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ABSTRACT

Eight examples of innovative and outstanding energy education programs are described. These programs were selected using state criteria and at least four independent reviewers. While Project Synthesis offered a desired state, these examples of excellence provided views of what is already a reality. The goals of an exemplary science program are provided along with the criteria for excellence. The programs described are: (1) "Pathways to the Future"; (2) "The Best of Energy--$1,000,000 Energy Challenge"; (3) "The Energy Management Center"; (4) "Energy Education at Houston's Outdoor Education Center"; (5) "The Energy Studies Center: Providing Skills For The Future"; (6) "Poss's Energy Posse"; (7) "Toward an Energy Consciousness"; and (8) "Energy Studies and Physical Sciences." Presented is a critique on excellence in teaching energy education. (KR)

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Focus on Excellence

Energy Education

Volume 3 Number 1

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Lynn W. Glass
Editor
March 15, 1985

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Chapter 1
Energy Education: The Desired State

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In most current physics and physical science texts energy is defined as a physical quantity that has the capacity for doing work. Neither the definition nor related classroom activities have changed for generations. What then is the cause for attention to an aspect of science that has been unchanged for so long? Most of our population and, indeed, most of the population of the world, has been unable to apply basic energy knowledge and laws to our everyday lives.

We have either not understood or we have chosen to ignore the facts learned in the laboratory and in textbooks. For example, we have not applied to our daily lives the knowledge that energy can neither be created nor destroyed and that when energy is converted from one form to another much of it is lost as unusable heat. Further, we have not seen the connection between the arithmetic of steady growth and the applications of this arithmetic to our growing demands for energy. These fundamental ideas in science and mathematics have no doubt been taught in every school curriculum. We have not, however, taught them in such a manner that our graduates can apply them to events outside the laboratory.

Soon after the Arab oil embargo began in October of 1973, it was realized that the American public did not understand or accept the fact that fossil fuel resources are in finite supply and that those supplies would be exhausted at some point in the foreseeable future. We chose to blame our rising fuel prices and long gasoline lines on the actions of others. After these initial frustrations, we chose to debate the number of years supply we had rather than focus on the fact that a finite resource is soon exhausted when the consumption rate grows steadily.

Out of this milieu came a new curricular emphasis called energy education. Groups such as the Energy and Man's Environment organization and the Project for an Energy Enriched Curriculum came into being. These groups, the former sponsored by the private sector and the latter by the public sector, recognized that if our energy crisis was to abate, we would need to deal with energy and its social implications in the classroom. Both groups, since joined by countless other groups, have developed energy education curriculum materials that could be used in conjunction with lessons in a variety of disciplines at all academic levels. After a decade of development it is time to assess our direction and our progress.

Studies by the National Assessment of Educational Progress and several independent investigators tend to support the conclusion that we have made progress in preparing our graduates to use science in their daily decisions and practices concerning energy use. Energy use data indicate that the American public can function with less annual energy consumption than was once thought possible. In spite of small gains in knowledge about energy and energy issues, a slight shift to more positive attitudes about energy use, and a demonstrated reduction in energy consumption, much education still remains to be accomplished.

This paper draws from the wisdom of a great many individuals, not all of whom are listed in the references, to create a framework from which to assess energy education programs. The framework defines the basic needs of all persons in all societies. The means by which the needs are met should be determined by individual situations.

Background

Project Synthesis, an activity funded by The National Science Foundation, identified four "goal clusters" and described actual and actual and desired states of science education within those clusters. The four goal clusters identified in Project Synthesis are:

1. *Personal Needs* Science education should prepare individuals to utilize science for improving their own lives and for coping with an increasingly technological world.

2. *Societal Issues* Science education should produce informed citizens prepared to deal responsibly with science-related societal issues.

3. *Academic Preparation* Science education should allow students who are likely to pursue science academically as well as professionally to acquire the academic knowledge appropriate for their needs.

4. *Career Education/Awareness* Science education should give an awareness of the nature and scope of the wide variety of science and technology-related careers open to students of varying aptitudes and interests.

Project Synthesis showed that virtually no attention is given to personal needs, societal issues, or career education in the existing science curriculum. The only goal taken seriously is that of academic preparation. Further, it emphasized that science has a low status in the school curriculum; it is neither required nor elected as often as science educators would like. Enrollments are low in spite of the obvious importance of science in our highly scientific-technological society. A significant advantage of energy education as a part of the science curriculum is that it can force emphasis on goal clusters 1, 2, and 4—the ones science usually shortchanges.

Goals and Student Outcomes

The objectives of a formal energy education program should center on (1) the investigation of energy use in our lives, our economy, and our society; (2) the development of skills in energy use and management at home, at school, and on the job; (3) the study of energy resources and energy conversions; and (4) the development of rational decision-making strategies to examine and to respond systematically to public and personal energy issues and energy policies.

Development of policy for a seemingly simple issue, such as mining coal in one state for use in another state, requires knowledge from a variety of traditional disciplines: biology, chemistry, economics, geography, geology, history, mathematics, physics, political science, and sociology. Although scientifically and technologically oriented, the basis for making decisions about energy issues is dependent upon the humanities, natural sciences, and social sciences. This knowledge is not foreign to the curriculum as we know it today. It is there in bits and pieces, albeit not always with the amount of emphasis science educators would desire. If we are to develop a scientifically literate society with an energy ethic we will need to drastically change the way we make use of this knowledge in our teaching and living. Knowledge will need to be used in terms of a gestalt. The relationships between social and natural systems must be stressed throughout a comprehensive energy education program.

Selected student outcomes have been identified in each of the four goal clusters utilized by Project Synthesis. These are intended to exemplify the kinds of outcomes representative of the desired energy education program.

Goal Cluster 1—Personal Needs

- To develop an energy ethic within the confines of interdependent natural and social systems and make life-style decisions consistent with the ethic.
- To identify personal opportunities for energy conservation and to be able to apply energy conservation techniques.
- To be able to anticipate potential energy resource changes and to make appropriate contingency plans.
- To identify the economic, environmental, political, and technological changes implied by energy issues and determine their implications on a personal level.

Goal Cluster 2—Societal Issues

- To demonstrate the knowledge, skills, and commitments required for making informed decisions about energy policy issues.
- To identify the trends and conditions that alter the supply of and demand for different energy resources.
- To describe the economic, environmental, political, and life-style implications of different energy scenarios at the local, regional, national, and international levels.
- To analyze scientific/technological programs and policies and project their near-, mid-, and long-term social, political, economic, and environmental implications.

Goal Cluster 3—Academic Preparation

- To identify the sources of energy and the proven and estimated reserves for each.
- To understand the flow and conversion of energy and the limits imposed by the first and second laws of thermodynamics.
- To make reasonable estimates of the life expectancy of known, non-renewable energy reserves for various patterns of growth or decline in rates of consumption.
- To evaluate the environmental, social, economic, and ethical implications of the use of various energy resources.

Goal Cluster 4—Career Preparation

- To identify careers created or modified by energy production, conversion, and conservation.
- To compare the entry requirements for various energy-related careers.
- To have the knowledge and skills to enter energy-related careers.
- To know where to find information on energy-related career programs.

Program Characteristics

The goals and student outcomes section of this paper addresses the broad nature of an energy education program. The curriculum designed to teach these goals must be equally broad. Lessons on energy needed for one's daily transportation can serve as an example for discussion of desired program characteristics.

Primary school children can identify their own transportation patterns and propose alternatives to these patterns. Intermediate grade children can continue to explore alternative personal transportation modes and can begin to investigate the nature of careers in various community agencies that cooperate in providing and maintaining transportation systems. As students progress through school

they can learn that the development and maintenance of transportation systems is an energy intensive operation interrelated with our political and social system. Sources of energy, efficiency of energy conversions, and the costs, benefits, and environmental impacts of different transportation modes can be examined and evaluated in the context of personal and societal transportation needs.

Our transportation example requires a broad-field curriculum model with students actively involved in the learning process. If students are to make decisions about their personal transportation needs, they must be provided with opportunities from the time they enter school to make and test choices under a variety of circumstances.

An interdisciplinary model might be best. In its ideal form, the boundaries of specialized courses are dissolved in favor of the pervasive ideas and characteristics encompassed by a broad based curriculum. Several examples were created by the Project for an Energy Enriched Curriculum (PEEC), and the interdisciplinary PEEC units are designed to fit into existing curriculum.

A related curriculum model with perhaps broader application is the infusion model. In this approach, instruction related to traditional curriculum objectives is supplemented with material on energy issues. For example, a high school social studies objective on the interdependence of political systems could include a discussion of the energy required to maintain their respective transportation systems. Since this model does not supplant the primary objectives of a curriculum, it has been more readily accepted by teachers than other plans. Several lessons in the PEEC units are designed for infusion.

With either the integrated or the infused curriculum model, the goal is to identify issues and/or problems which can be generalized and broadly applied to various learning experiences. With both models there is a need for good curriculum materials and for planning among all teachers in a school. Curriculum materials that are free of bias, provide divergent viewpoints, and involve students in a wide range of learning activities are a must. Teachers and administrators need to coordinate what is taught in a grade as well as between grade levels to achieve continuity and a graduated approach to more abstract energy concepts.

The world is full of issues, including our transportation example. How should government subsidize a public transportation system? How much should the subsidy be? Teachers and curricula both need to be prepared to deal with issues that, though often controversial, cannot and should not be avoided. Students need to be given an opportunity to examine the evidence objectively and to use the evidence in decision making. Energy education can provide this opportunity.

Our transportation example also requires that energy education go beyond the confines of the typical classroom. Much is learned from the world around us. Parents, teachers, and community members serve as role models as we develop our transportation habits. Businesses, industries, and government agencies play major roles in providing the means and rules by which we transport ourselves and our products. To develop, implement, and maintain an exemplary energy education program, representatives of all these groups must be included.

In this way, an ideal energy education program builds upon existing instruction, organizes seemingly unrelated academic disciplines, explores issues and decisions, uses a diversity of expertise, and fits into the present educational program. Students view this instruction as logical and relevant to their needs. They learn to identify, synthesize, apply, and evaluate information for decision making. They also realize the value of knowledge and the importance of the individual in resolving problems.

Characteristics of Instruction

There are many teaching strategies that can be used to satisfy the previously described program goals. Good teachers will use a variety of strategies and techniques to reach the desired end. The selection of strategies and techniques will be dependent on desired outcomes, student characteristics, and teacher ability.

Two instructional characteristics remain constant. All teachers must establish a free and inquiring learning environment for the practice of decision-making strategies. As numerous studies have reported, students learn best what they have practice doing. If we expect our students to develop a personal energy ethic, we must provide them with opportunities and encouragement to gather information about problems significant to their lives; to devise solutions for the identified problems; and to test their solutions. Teachers share with research scientists a major obligation: to fearlessly defend the freedom of scientific inquiry and opinion.

Teachers knowledgeable about the topics being taught possess the second characteristic. Teachers, like research scientists, have a social and ethical responsibility to proclaim benefits, warn of risks, and discuss quandaries. Without knowledge it is impossible to carry out this responsibility. Teacher certification standards are designed to assure some minimal level of knowledge in the teacher's chosen field. We must be assured that teachers of energy education also possess an adequate level of knowledge.

There is no single solution to the energy problems of this country; energy issues are open issues. We have time now to take responsible action. Energy education must serve the learner and not manipulate or impose fixed beliefs. Instruction must provide an opportunity to make decisions while considering ethics and values; it must include the acquisition of knowledge and inquiry skills. Discussions must be open and probing and should enhance the long-term development of the learners rather than the short-term inculcation of "good" energy habits.

Student/Program Evaluation

Student and program evaluation must focus on the development of higher order cognitive skills and value systems. The four goal clusters provide examples of the types of behaviors to be evaluated in an energy education program. The diversity of affective and cognitive student outcomes makes a variety of evaluation procedures and techniques necessary. The traditional short-answer, multiple choice, true-false, matching, and essay items are generally appropriate for measuring cognitive outcomes. Some affective behaviors can be measured adequately by traditional means, but certain affective measures require observation schemes and student-kept records for in-class and out-of-class time. Regardless of the evaluation techniques selected,

they should be designed to measure the diversity of intended student outcomes.

Summary

Energy education can provide an excellent vehicle to prepare learners to face issues and solve problems in a scientific-technological society. Some of the characteristics of an exemplary energy education program include:

- The need for energy literacy must be clear in curricular materials and instructional activities.
- Program goals and student outcomes must address a hierarchy of intended affective and cognitive outcomes.
- Content and instructional activities must include the humanities, natural sciences, and social sciences.
- Inter- and intra-grade level articulation and coordination must exist for the progressive development of energy concepts, practices, and attitudes.
- Issues and problems must be dealt with in an open, objective manner.
- The community should be a reservoir of problems and issues for study as well as a source of enlightenment.
- Teachers should have a broad knowledge base and the instructional skills needed to maintain an objective, inquiring classroom.
- Evaluation must reflect the diversity of intended affective and cognitive outcomes.

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Chapter 2
Pathways to the Future

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Each year the Onslow County Schools, the Camp Lejeune Dependents Schools, and the Onslow County Citizens Energy Advisory Commission in North Carolina sponsor many activities that provide opportunities for adults and students to actively or passively participate in energy education activities through poetry, art, music, history, philosophy, religion, drama, science, and sociology. The culminating event is an energy fair held at the Jacksonville Mall. The purpose of the program is to provide energy education and a public forum for the exchange of ideas about energy conservation and alternative energy sources for more than 150,000 residents in the area. This program, which has been in existence in Onslow County during the past five years, brings significant energy questions to the attention of the county's public and private sectors in an attempt to stimulate and prepare citizens to undertake new approaches to energy conservation. Some of the questions are: Is the United States prepared for the future? Have Americans developed a philosophy that supports energy conservation? Are Americans willing to seek alternative sources of energy?

We in Onslow County have felt that the time has come for us to consider the historical, sociological, economical, moral, and philosophical impact energy resource conservation poses for humankind. Knowing that advancement and/or survival of a society is determined to a great extent by the type, abundance, and development of its energy resources, we ask, "Can we meet the challenge?" We believe we can! If we seek solutions to impending energy shortages with the same spirit and zest that our forefathers demonstrated, we will become attuned to and prepared for the problems of tomorrow. The challenges each of us successfully face today may not only determine our future survival but the survival of humankind.

This program provides opportunities for adults and students to participate through art, literature, poetry, music, drama, panel discussions, exhibits, displays, and various forms of media. The format of this approach helps participants to reflect and/or share a common concern for the ethical and social values of energy issues. Eleanor Swinson, a science teacher at White Oak High School, aptly summarizes the energy issue:

> Americans must now take a serious look at the effect and consequences of the use of their major energy source: the hydrocarbon chain derived from petroleum. The access to this major source is limited and its use is polluting the environment.
>
> Additionally, American values, attitudes, and behaviors must be altered in meeting the challenges of current technology dealing with the hydrocarbon chain. Even though future development of alternative energy sources will free Americans of dependence on naturally produced hydrocarbons, no one knows how far away this technology is.
>
> At present, all energy sources under development, with the exception of solar, are finite; they have a calculable end of supply. Conserving energy sources now, will "buy" Americans the time needed for this technology to be developed and refined.

The Onslow County/Camp Lejeune Energy Program began in the summer of 1979 when Hirshel Brown, a former Onslow County Commissioner, proposed the formation of an Energy Commission. Its main purpose would be to educate the citizens about energy conservation. Once

approved and funded by the county, the Energy Commission quickly formed with representation from each of the five governing bodies in the county, each utility, the Chamber of Commerce, the schools, and the private sector. The 26 members were appointed for two-year terms. A part-time coordinator was hired and has served in this position since its inception. Some accomplishments of the Energy Commission during the first five years of its existence include:

- Established energy monitors for public buildings.
- Conducted five county-wide energy fairs.
- Set up educational booths at five county fairs.
- Implemented a county-wide car pool program.
- Initiated a resource recovery study for the county.
- Influenced county schools to establish state accreditation goals in the area of energy education.
- Received the President's Award for Energy Efficiency in 1980.

The Onslow County Energy Education Program began when the Education Committee planned the first energy fair as a culminating event to activities dealing with energy education. Eleanor Swinson chaired this committee with the assistance of Ann Watkins of Brewster Junior High School. The first energy fair laid the groundwork for succeeding fairs which became so popular that it was necessary to move them to the Jacksonville Mall in 1983.

In accordance with the purposes of the program, several other activities were added to the fair to increase participation and energy awareness. The additional activities included staged performances, oration contests, and poetry contests. These activities increased student involvement, especially in the elementary grades, and provided greater integration of subject matter. As student involvement increased, so did parent involvement and awareness.

The utility companies have been active participants of the program from the beginning. They have presented programs, exhibits, and demonstrations in the schools. In addition, utility employees have judged school fairs.

In 1982, the Conservation Award was created for the school conserving the most energy during the school year. This award provided a competitive spirit among the schools and a positive influence upon student behavior. Also in 1982, the Onslow County school system developed curriculum guides in energy education for grades K-3, 4-6, 7-9, and 10-12 which were later shared with the Camp Lejeune Dependents' school system.

During the 1983-1984 school year, the education committee along with the energy commission members promoted Energy Education Week, March 22-26. Energy activities, performances, contests, and exhibits were held at the mall during the week. On Friday, March 23, all the students observed National Energy Education Day. In grades 4-6, the students played Energy Savers Bingo in their classrooms with prizes donated by the commission. Meanwhile, the county energy fair at the mall was open all weekend for the public to see energy projects, exhibits, slide presentations, and performances. Energy Sunday closed the week.

Our Program

The goal of the Onslow County/Camp Lejeune Energy Program is to stress and promote knowledge of ways to preserve the environment and its natural resources, and to assist all participants in seeking solutions to present and future energy demands.

The following objectives were established to meet this goal:

- Increase knowledge of the derivation, conservation, and alternative uses of energy.
- Use and coordinate energy education within the county school systems (public, private, parochial, and military) with the cooperation of local business and industry.
- Facilitate the development of ideas to show the relationship between the practical application of value judgments and energy use.
- Increase public awareness of scientific limitations, while promoting the concept that conservation is based on individual value judgments.

The Onslow County Citizens Energy Advisory Commission, the Onslow County and Camp Lejeune School Systems, and the private and parochial schools work together each year to develop and deliver this program. By utilizing local educational systems, businesses, industries, churches, government agencies, and community resources, we have successfully created sensitivity to humanistic aspects of energy conservation through community involvement.

Organization of the Curriculum

The need for energy literacy is clearly evident to students from the selection and use of curriculum materials.

- *Curriculum Materials* The schools use locally developed curriculum guides; the Energy Wise Program, Energy Activities for grades K-3, 4-6, 7-9, and 10-12 which were developed by the North Carolina Department of Public Instruction; and K-3 and K-4 Experiences in Energy Packets furnished free of charge from the Carolina Power and Light Company. All these materials provide a sequence of energy concepts to be taught in grades K-12.
- *Other Instructional Materials* Each year the energy coordinators produce several newsletters for grades K-12 which provide additional information for teachers and energy exercises for students.

  In 1984, the Bingo Saver Game was developed to serve as a follow-up activity to classroom instruction in grades 4-6. The game was played on National Energy Education Day, and students received prizes donated by the Onslow County Energy Advisory Commission.

The curriculum uses the community as a reservoir of problems and issues for study as well as a source of enlightenment.

- *Energy Sunday* Dr. Jim McGiven from the Department of Religion at the University of North-Wilmington provided biblical references to energy conservation. This information was mailed to local churches so the minister could include these references in his or her sermon on the day specified as "Energy Sunday."
- *Panel Discussions* Panel discussions were offered at the public library which addressed the areas of philosophy, history, science, sociology, economics, and religion. Videotapes of these discussions were also made available to area students in grades 7-12.
- *Other Support Agencies* The Alternative Energy Corporation funded a project sponsored by the Council on Aging. This project, called the Senior Energy Savers, involved weatherization of homes belonging to senior citizens.

The Onslow County Energy Commission provided the manpower for the project.

Other agencies that have contributed exhibits, displays and/or prizes for the Energy Fair are the Boy Scouts and Girl Scouts of America, North Carolina Science Teachers Association, and the Jacksonville Mall Association.

The local utility companies have provided an energy efficient house model for the schools, an energy consultant upon request, and free energy audits to homes.

Inter- and intra-grade level articulation and coordination exist within the curriculum for the progressive development of energy concepts, practices, and attitudes.

- *Energy Monitors* Each school has designated certain individuals to closely monitor the school's yearly energy use. These school monitors are also responsible for dissemination of all materials and announcements prepared by energy coordinators and supervisors.
- *State Accreditation* The Onslow County Schools System established state accreditation goals in 1982-1983 for the area of energy. This was the first time in North Carolina that a school system had viewed energy instruction to be as important as instruction in reading, mathematics, science, and social studies.

Objectives and Learning Activities

Content and instructional activities incorporate the humanities, natural sciences, and social sciences. Units on conceptual areas such as Energy: A Basic Need, Energy-Related Environmental Effects, Energy-Related Societal Effects, Energy Policy, and Energy Futures constitute the major unifying threads in energy education programs of excellence.

- *School Energy Fair* Each school is responsible for conducting a school energy fair in grades K-12. Students are asked to prepare an exhibit that demonstrates their knowledge of energy and conservation. All entries are then judged according to creative ability, scientific thought, skill, thoroughness, and clarity. The top five winners are selected for display at the energy fair.
- *County Energy Fair* Each school submits the top five exhibits for county competition from the following categories: Primary (K-3); Intermediate (4-6); Junior (7-9); Senior (10-12). Only class projects are accepted from the primary (K-3) category. All other entries are individual projects in grades 4-12, with no more than two students working on any one project.

  All these entries are then judged in each category according to the school energy fair criteria. All school and county winners receive a blue ribbon, and all county winners receive awards. Additional awards are given during the awards ceremony at the mall.

  The North Carolina Teachers Association awards $25.00 to the science/classroom teacher of the first place winners in grade 4-6, 7-9, and 10-12 categories. The Onslow Clean County Committee awards $25.00 to the best recycling project, and the Onslow County Arts Council also awards $25.00. The Society of Military Engineers presents cash awards in each category based on criteria similar to those above.
- *Poetry Contests* A poetry contest is conducted prior to the fair. Students in grades K-12 are asked to submit poems dealing with a specific energy topic. The librarian from the public library judges all entries and selects a first, second, and third place winner from each K-3, 4-6, and 10-12 grade category. Students who win at the county level receive ribbons and gift certificates from businesses in the mall.
- *Bumper Sticker Contests* The Camp Lejeune Dependents School sponsored a bumper sticker contest in grades K-12 in order to increase energy conservation awareness. Since all entries were prepared by students on bumper sticker paper, they were readily available for use by students and parents. The winning entries were printed and distributed free to school personnel.
- *Public Speaking Contests* In 1983, a public speaking contest was sponsored for all 7-12 grade students in an effort to provide a public forum for an exchange of ideas concerning new approaches to energy conservation. Participating students were judged by members of Toastmasters International according to specific criteria.
- *Stage Performances* For the energy fair, many schools prepared stage performances consisting of skits, mimes, and choral pieces. Many of these performances were provided for parent organizations, as well as the general public at the mall.
- *Conservation Award* A conservation award consisting of a plaque is presented to the county school and base school that conserved the greatest amount of energy during the year. This project promotes a competitive spirit between schools. In some cases, schools went for an entire day without electricity—serving bag lunches, turning off lights, and omitting public announcements.

Teacher Characteristics

Our staff development was provided to K-12 teachers by consultants from the North Carolina State Department of Public Instruction and from the utility companies. Every effort was made to integrate the energy/science area with the language arts/communication skills area. Additionally, field trips to the nuclear plant in Southport were scheduled for teachers and students.

Using the curriculum guides, our teachers provided instruction and guidance to help students prepare worthy energy projects, public speeches, poems, etc., as role models and as instructors, our teachers help students develop conservation behaviors that will reduce energy consumption in school and at home.

We evaluate our teacher-made tests and system-wide checklists prepared for the instructional area. An evaluation survey of the fair is conducted by the Coastal Carolina Community College in Jacksonville. Extensive record keeping determines which school conserved the most energy during the year.

Evaluation

Though the main purpose of the Onslow County Energy Education Program was to promote energy conservation, it soon became equated with economic savings. As a result, the program was enthusiastically accepted by the public. Additionally, the coordination and support of the program by the energy commission ensured its success in the schools and the community. As each school system added the program to its existing curriculum, they soon realized the economic gains that could be found through energy conservation.

Another strong factor attributing to the success of the program was the support from the county commissioners. They appropriated a minimal amount of money for the energy fair and provided a part-time coordinator for energy education. The county commissioners were united in their efforts and strongly committed to the promotion of energy education within the area.

Support from local businesses and industries contributed to the program as they saw the economic gains acquired through conservation. Often donating time and money, these businesses provided much support to the energy program. The utility companies provided resource personnel, demonstrations, exhibits, free materials, and teacher inservice to the school systems.

Implementation costs have been minimal. Funding from the county for the first three years totalled approximately $1500.00. Part of this went to the energy fair for ribbons and cash awards. The costs to the schools were minimal since the program was added to the existing curriculum. Curriculum materials were made available on either a no-cost or minimal-cost basis from state and local educational agencies or utility companies. Teacher inservice, demonstrations, exhibits, and speakers were also provided by the utilities free of charge.

Since the energy fair has been held in Jacksonville Mall, there has been no charge for the use of the facility. Moreover, 80 percent of the funding for prizes and awards comes from the business and professional community while the time and effort needed is provided by volunteers. There is no cost associated with fair maintenance. The success of the energy program can be attributed to the dedication and commitment of people in community groups and local government who give their time and services to the school.

Our energy education program could be easily transported and established in other communities. Any community group (commissions, civic clubs, youth organizations, service clubs, etc.) with an interest in energy education and conservation could easily implement such a program in its community and schools. Since teachers are always receptive to activities and strategies for the classroom, the infusion of energy education into the existing curriculum is an easy task. Student energy projects can be used in local science fairs already in existence. Performing arts, music, writing, and other subject areas can be integrated with the energy curriculum.

Using teacher checklists, the school systems and teachers have evaluated the effectiveness of the program. This information was acquired as part of state accreditation procedures in Onslow County. Following analysis of these teacher checklists, it was determined that by June 1983, 88 percent of the 1,109 third grade students, 89 percent of the 1,159 sixth grade students, 89 percent of the 1,342 physical science students, and 91 percent of the 1,179 biology students mastered 80 percent of the energy goals/concepts taught at their particular grade or subject level. This information showed that over 80 percent of all third, sixth, ninth, and twelfth grade students had an awareness of and a positive attitude toward energy conservation.

Plans for Improvement

Since the evaluation of the Onslow County/Camp Lejeune Energy Program is a continuing process and one that reflects changing community needs, efforts are made each year to improve the existing program. The following needed improvements have been determined:

- Increased community involvement in order to reach more citizens.
- More parent involvement to ensure that energy conservation practices are carried out in the home.
- More effective communication between the schools and community to emphasize everyday problems with energy conservation.
- More staff development and inservice for teachers in energy education.
- More communication between commission members and schools about educational programs.
- Better evaluation procedures to determine the success of the program for individual students.

In an attempt to meet these needs, the schools plan to increase community awareness of energy conservation by promoting parental involvement and home energy activities. Students in grades 3-8 will conduct home energy audits by reading their electric meters over a seven day period, maintaining a log, and determining the kilowatt usage and cost during certain times of the day. Through this home interaction, we hope to increase awareness of energy consumption and the need for conservation. The public utilities will also be involved in an effort to involve students and parents in peak-load management programs.

Plans are being formulated to provide more teacher inservice and more in-depth evaluation procedures. The evaluation process will continue to adapt the program to changing community needs while using the program's strength. These strengths are:

- Wide range of interdisciplinary activities for the varied interests and abilities of students.
- Staff development and inservice training for teachers in energy education.
- Special activities like the energy fair, home energy audits, speakers, demonstrations, and exhibits dealing with energy education from local schools, businesses, and industries.
- Availability of curriculum guides and activities in energy education.
- Adoption and infusion of energy education in existing curriculum of all school systems.
- Supplemental materials available from utilities, North Carolina Department of Public Instruction, national and state resources.
- Availability of community resource persons.
- Coordination of activities between all school systems.
- Commitment and support of Energy Commission in energy education.
- Involvement of parents and community at energy fairs.
- Suitable site for energy fair.
- Revision, refinement, and re-direction of energy education program during the year.
- Coordination between local and state education agencies.
- Funding by the county commissioners.
- Financial support from the community in energy education efforts.

In conclusion, a successful energy education program requires a dedicated group of people who have the courage and initiative to implement and conduct the program.

Chapter 3
The Best of Energy—A $1,000,000 Energy Challenge

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The children of this country must adjust their lifestyles and set social, political, and economic policies to deal responsibly with conditions into which they were born. They must learn that they have a measure of control over their personal energy problems. Children will inherit conditions shaped by preceding generations. This is not unique. What is unique is that for the first time in the earth's history, we face the depletion of some natural resources, particularly the fossil fuels. For those of us who grew up with the idea of endless, unlimited energy, this challenge will test the limits of our problem-solving and decision-making skills. A different idea needs to be instilled in today's students.

With this situation in mind, a cooperative effort of the Colorado State University Cooperative Extension Service in Denver County and the Denver Public Schools has resulted in two *The Best of Energy Books.* An outgrowth of these books is the $1,000,000 Energy Challenge, a voluntary energy conservation contest for Denver public elementary schools. The million dollars is the possible savings this program could generate.

Our Program

The goal of *The Best of Energy Book* is to develop an awareness of how limited our energy sources are. This awareness ought to lead today's young people to a more energy-conserving lifestyle. The objective of the program is to have teachers recognize the importance of energy education and teach it in their classes.

This approach to energy education is interdisciplinary; activities encompass the areas of science, social studies, art, mathematics, and language arts. The activities are designed to emphasize changes in attitude and lifestyle through energy awareness. Since energy topics are taught in conjunction with the basic elementary school subjects, skills in those subjects are reinforced through energy education.

The Best of Energy Book is in two volumes. One is for grades 1-3 and the other is for grades 4-6. The lessons in the books are grouped in sections: art, language arts, mathematics, science, and social studies. The book contains four message keys to energy education:

- The sun is the main source of all energy. Its power creates other sources of energy, such as oil, coal, natural gas, and food.

- Energy is the ability to do work through moving, lighting, or heating things. Energy is lost when it is passed from one source to another.

- Some of our natural resources are renewable; some are nonrenewable. Conserving and sharing limited resources becomes especially important as the world becomes more crowded.

- We must be responsible for the effects of our use of energy on the environment and the economy.

The teacher knows the basic idea of the lesson by noting the logo next to the title of the lesson. Each lesson contains a background section which prepares the teacher for the type of lesson at hand. Sample lessons are included in the book.

The subject area lessons are followed by a series of short (15 minutes or less) "sponge" activities. Examples of these activities are also included. The books also contain a bibliography which lists curriculum materials, books, and reference materials; sources of information; and an educational film list.

Once *The Best of Energy Book* was developed for elementary school energy curriculum, each Denver public elementary school received the two volume curriculum along with announcements of the availability of a *The Best of Energy Book* workshop. If five or more teachers in an elementary school expressed interest, an hour long workshop was provided at that building before or after school. These workshops provide teachers with the following: information about the design and format of the books, teaching demonstrations of some of the lessons, models of energy construction projects which are available for first-hand observation, and time for questions and answers regarding the program and related areas.

The goal of the $1,000,000 Energy Challenge is to teach students about energy conservation by actively working to reduce energy use in their school buildings. Individual schools are asked to participate in the $1,000,000 Energy Challenge. Those schools that agree to participate send the principal, a teacher, a parent, and the head custodian to a half-day workshop. The workshop covers the "how and why" of school energy conservation. There are separate sessions for principals, parents, custodians, and teachers. Each group covers specific suggestions for practicing/teaching energy conservation. Each school then drafts a specific energy conservation plan.

The workshop is followed with an energy tour of the school. During the tour, a student energy team explores ways to save energy. This is often followed up with a lighting survey to determine optimum use of shades and lights.

During the contest challenge period, schools compete to save the greatest percentage of energy. The savings are compared to a three year base period. Each challenge runs into a two month cycle of which there are four per year. Schools whose energy savings are at least five percent receive an Energy Challenge flag. Schools whose savings are over ten percent have an award assembly. The school that conserves the most energy receives a special award and recognition.

Evaluation

With the critical backing of the operations and maintenance departments, custodians have achieved spectacular savings with no cost increases. The energy challenge has provided recognition and feedback to encourage such efforts. In some cases custodians are working closely with student energy teams to teach them how the school operates and how to conserve energy.

The schools involved in the initial $1,000,000 Energy Challenge saved a total of $7000 by the end of a seven week period. Teacher and student participation was excellent, and the program united the entire school in conserving energy. Based on this success, the Denver Public Schools contracted with the Colorado State University Extension Service to provide *The Best of Energy Book*/$1,000,000 Energy Challenge to elementary schools from November 1982 through the end of 1983. During this period additional introductory workshops were held, 45 new schools joined, over $180,000 was saved, and over 21,000 elementary school students had participated.

Plans for Improvement

The Colorado State University Extension Service and Denver Public Schools have continued to provide inservice training in *The Best of Energy Book* and have published *Energy on the Brain/Energy News*, a bimonthly newsletter for teachers that contains energy news and new lessons. Community Resources, Inc., a speakers' bureau for the Denver Public Schools, offers "Energy Today"—a classroom presentation to teach energy concepts to students. This program has been presented to approximately 1200 students in Denver's elementary schools.

An energy monitoring program has been developed that enables schools to monitor energy use with their own microcomputers. At this point in time, the computer program is not being used by all schools. When this happens, the monitoring efficiency will greatly improve.

Successful continuation of the program requires some person(s) to provide central coordination and record-keeping. In Denver Public Schools this has been done through the office of Science Education and a contract with the Denver Energy Resource Center.

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Chapter 4
The Energy Management Center

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The Energy Management Center (EMC) is the science field trip center for the district school board of Pasco County's 33 elementary, middle, and high schools. The EMC functions to provide daily energy-related programs for students in grades 4-12 as well as inservice training, technical support, and curriculum materials. Total student enrollment for the 1983–1984 school year was 26,645, of which 13,365 participated in programs at the center. Total student population is 93% white, 4% black, 2% Hispanic, and 1% Asian, Indian, or Eskimo. Ninety-three percent of the 1983 senior class graduated.

In 1981 the population of Pasco County was 204,598, ranking Pasco as the fourteenth largest county in the state of Florida. Approximately 6,000 residents are considered nonpermanent. Forty-two percent of this population graduated from high school; five percent of this population has four or more years of college education. Agriculture is important to the economy of Pasco with 90 percent of the land in agricultural or related uses. Of the work force, 40 percent is considered a retirement community. While this is still somewhat true, the county is growing at such a tremendous rate that it is becoming known as a suburb of the larger neighboring cities in the Tampa Bay area.

The EMC is situated on 10 acres in a coastal salt marsh adjacent to the Gulf of Mexico in Port Richey, Florida. The facility has two classroom buildings, five seawater tanks, a boardwalk to a mangrove island, and an observation tower. A full-time staff of six teachers and two support personnel instructs and assists the students who visit the center as well as trains other teachers to use the site and develop materials. The EMC hosts public workshops on a variety of energy-related themes and the site is used by adult education and community college classes as well.

History of the Program

The Energy Management Center concept developed from the growing national awareness of our energy problems that resulted from the OPEC embargo of 1973–74. Students in public schools and, indeed, the public at large did not understand the often complex scientific and social factors that govern our use of energy. It was recognized that public education would have to resolve part of this problem.

Early in 1974, a needs assessment was conducted among students in Pasco County. It was found that students entering the fourth and ninth grades displayed a lack of skills to solve problems dealing with energy supply conservation, and the effects of increased energy use. Few students at those grade levels could relate careers and jobs to energy supply and demand. Even fewer students recognized the relationship between their own attitudes, values, and behaviors and the use of energy in our society.

The results of the initial needs assessment revealed that:

- Ninety percent of Pasco's fourth grade students lacked knowledge and skills about the nature of energy.
- Eighty percent of the fourth grade students lacked knowledge about living energy systems.
- Fifty percent of the fourth grade students lacked the ability to analyze the relationship between their value system and their use of energy resources.

Concerned curriculum supervisors and school board members recognized that lack of scientific preparation and pre-

vailing attitudes toward both non-renewable resources and the environment were contributing to this problem. Instruction in the traditional classroom format had failed to increase scientific literacy and environmental awareness. Therefore a plan was developed to combine classroom instruction with trips to a separate science facility. The science center would serve as a motivating and enriching experience for students.

A planning grant was received in July 1974 from the Elementary and Secondary Education Act (ESEA) Title III federal grant program. The project began developing its staff, materials, and curriculum in August 1974. A committee of teachers, administrators, university consultants, and curriculum specialists met to determine the scope and sequence of the curriculum and to devise innovative strategies to enable students to attain the selected objectives. This group also began the writing and development of student materials.

Next, a site for an outdoor classroom was located. The site proved ideal, with existing seawater tanks, easy access to nearby marshes and island hammocks, central location in the district's most populated area. After renovation students began full scale program participation in the spring of 1975.

A program of instruction evolved that combined activities in the classroom, EMC, and community. This program appeared to offer the best solution to student needs in the areas of energy conservation and attitudes toward energy use and the environment. Each of the components was closely coordinated with revisions based on evaluation data and user feedback. This provided a unique system for resolving identified student needs.

The program had three years of ESEA Title III/IV C funding. In 1978 the program was reviewed by an independent, three-person, out-of-state validation team. The team visited the project, reviewed evaluation data, observed teachers and students, and talked with parents. As a result of the visit, the team concluded that the EMC program was effective in achieving its objectives and was recognized as an educationally and statistically significant replicable and practical approach to energy education. The team recommended that districts wishing to duplicate the program develop an outdoor science center as an integral part of the energy education program.

EMC is now totally supported by the district school board of Pasco County. In 1979 an expansion program was initiated to increase the number of buildings on the site and to increase student participation.

Since 1979 the original fourth and ninth grade physical science programs have been supplemented with programs for fifth, sixth, and eighth grade earth science, biology, ecology, ocean science, chemistry, physics classes, as well as educable mentally handicapped classes. During summer months, the EMC hosts a daily enrichment program for gifted students in grades K-6.

Our Program

All students enrolled in the involved grades and classes are scheduled to attend the EMC each year. Program design requires the students to participate in hands-on experiences relating to energy, science, and the environment. The lessons help meet district science curriculum objectives not easily met in the classroom.

The EMC's indoor classroom space is at a premium but the outdoor classroom space is extensive. Up to 60 elementary and 60 secondary students simultaneously use the center each day. Rain or shine, fair or foul weathr, the center operates daily. Fourth grade students visit for a two-day program and all other students attend for a one-day field trip. Students are bussed to the EMC site and arranged into groups of not more than 15 students per instructor. This ratio allows maximum student participation, better student-teacher interaction, and the safest situation for outdoor activities.

At the elementary level, classroom teachers are a vital part of the EMC curriculum. The EMC staff conducts training workshops to show teachers how to conduct outdoor activities on field trips and how to integrate the field experiences into their classroom science and social studies lessons. Field trip activities can be reinforced with workbooks, written assignments, and laboratory activities at the school. Equipment and materials are provided by the EMC staff. The elementary classroom teacher does not simply follow along with a class while they participate in the activities; they are an integral part of the day's activities.

At the middle and secondary school levels, programs involve students with intensified field studies and problematic approaches to energy and environmental sciences. The classroom teachers do not attend the field trip with their classes at this level but they are provided with pre- and post-activity suggestions that relate the field trip to the classroom science curriculum. An evaluation of each student's participation in terms of behavior and content mastery is returned to the classroom teacher along with all written materials and data sheets their students completed while at the EMC.

At all levels, affective goals are concurrently met along with cognitive goals. The value of energy and an appreciation of its effects on the environment are stressed through direct experience in the unique outdoor setting.

Curriculum Overview

Fourth Grade Fourth grade teachers are provided with a three-day inservice program to prepare them to deliver the in class component of the energy program and the activities for the field trip.

Students work through 3 three-week modules based on the energy theme (Module A: Let's Learn About Energy; Module B: Nature's Energy; and Module C: Man and Energy). These modules were developed by the EMC under a federal grant and include resource information, laboratory experiences, and AV aids. Modules, laboratory kits, and AV materials are sent from the EMC directly to the classroom teacher. During the time the students are participating in the classroom program, they also visit the EMC twice for supplementary field activities. EMC activities for fourth grade students include:

- Studying energy from the sun and using full-size functioning solar collectors and wind machines.
- Performing simple experiments around solar, wind, and other energy themes.
- A nature hike comparing coastal marsh and hammock ecosystems in terms of food chains and energy flow in a food web.

- Studying gas engines in a demonstration laboratory which begins with examples from the industrial revolution and ends with futuristic engines.
- A collecting trip to a salt marsh and mangrove island and capturing sea life with seine nets to appreciate energy-related effects on ecosystems.
- Drawing pictures and writing cinquains about energy and nature.

Fifth Grade Fifth grade teachers receive a one day inservice program that prepares them to conduct two field trip activities and to relate the EMC experience to their classroom science curriculum using the Merrill science series. Fifth grade students participate in energy-related activities that include:

- Using stream tables to study rain splash erosion and effects on simulated landforms.
- Hiking to look for weathering and erosion effects on a local habitat.
- Studying the transition of potential energy to kinetic energy in a pendulum laboratory.
- Experimenting with heat conduction, convection, and radiation: thermometers: and liquid crystals.
- Experimenting with marbles, cars, and inclined planes to study energy transfer.

Sixth Grade Sixth grade teachers receive a one day inservice program which prepares them to conduct one of the field trip activites and to reinforce their classroom science curriculum with the EMC experiences. Sixth grade students participate in activites based on units from the Merrill science series that include:

- An acids-bases laboratory looking for energy changes in chemical reactions.
- A light energy optics laboratory.
- An electricity laboratory that progresses from production of static electricity through electrical circuits.
- Outdoor Biological Instructional Strategies (OBIS) activities based on animal requirements for energy.

Eighth Grade Earth Science Classes The earth science field trip is designed as an enrichment experience. Activities relate classroom studies to the unique coastal setting of Pasco County. The program builds upon the energy themes introduced on field trips in grades 4-6. Earth science activities include:

- Measuring Your Environment—a series of tidal and weather studies that involve students in measuring specific parameters and predicting their influence on organisms in the ecosystem.
- Wind Energy—a group of experiments that study design factors.
- Greenhouse Effect—several activities that relate cooling curves and insulation studies to the effects of heat storage capacity.
- Collecting marine life with seine nets and observing adaptations necessary for survival in an estuarine environment.
- Comparing saltmarsh and mangrove shorelines for natural energy flow and for effects of vegetation on erosion control.

High School Classes Whenever possible, a pre- and post-laboratory activity, developed by the EMC staff, is incorporated into a classroom mini-unit. In some courses the material contained in the text (Merrill or Scott-Foresman) is sufficient preparation for the field trip and relevant chapters are indicated to the classroom teacher. The high school program provides students an opportunity to practice newly acquired laboratory skills in a field situation and to apply their knowledge of energy to real world problems. Programs are continually updated to reflect current issues in energy and science.

Biology I classes study ocean plankton communities using the tidal channels at the site and the seawater tanks. A microscope laboratory is provided. Students use plankton nets and Secchi discs to map a transition zone between the salt marsh and upland hammock using a transect technique. A complete profile of the community is developed by identifying native plants, performing soil and climate analyses, and mapping elevation changes. This information is then recorded on graph paper, creating a profile of a biologic community. Classroom follow-ups include simulated quadrant studies of animal populations and value judgments concerning construction sites in coastal habitats.

Biology II students learn to use a plant key to identify native vegetation. These students then go into the nearby estuary to collect samples of fish. A fish morphology and anatomy laboratory is then conducted using the catch. Follow-up activities in the classroom include using a fish key.

Chemistry class trips emphasize analysis of seawater. Dissolved oxygen, salinity, nitrates, phosphates, pH, and pCO_2 are all determined using titration and colorimetric procedures. Students are introduced to field sampling techniques and practical applications of chemistry. Students use techniques and instruments rarely available in high school chemistry laboratories such as hydrometers for specific gravity determinations.

Physical science classes participate in electric circuit laboratories using circuit boards and computer tutorials, and individual experiments on magnetism, motors, adhesion/cohesion, lenses, and density. Solar energy experiments with design factors, engine demonstrations, and energy simulations on the Apple IIe computer using software from NSTA round out the physical science activities.

The EMC physics trip is devoted to light energy and involves students in an exploratorium-type day of hands-on laboratory experiences. During this trip students investigate lasers, holograms, wave tables, optics benches, flame spectra, absorption spectra, fiber optics, ultraviolet radiation, infrared radiation, mirrors and lenses, and light intensity. An Apple IIe computer is used in two of the laboratories in both the analog and digital mode.

Ocean science and ecology programs were added in the 1984-85 school year. The ocean science classes introduce concepts of abiotic and biotic limiting factors which influence the carrying capacity of the estuary. Students use various marine instruments to test chemical and physical properties of seawater. Students compare morphological adaptations of various species of fish which allow them to survive in the habitats of the adjacent estuary. The ecology groups use field techniques to determine the distribution patterns and density of organisms in the wetlands. Students also play games which simulate the food web interactions.

Educable Mentally Handicapped Classes Students in EMH classes

from grades 4-12 participate in activities that reinforce the district science skills selected for special students. Records are kept for each group and activities are provided that help students move through their skills list. Consequently, activities vary from year to year and from group to group based on the skills acquired. The majority of activities are modified from the existing curriculum for other programs offered at the EMC.

Equipment and Materials

The EMC fourth grade program is available for dissemination. While this part of the program was intended for the average fourth grade student it lends itself to enrichment programs and programs for learners with low motivation. The program offers the flexibility of being used within a single classroom thus allowing multiple-class use and district-wide adoption.

Evaluation

Throughout program evaluation in 1978, students in treatment groups consistently attained at or above criterion level. To the extent that replication and consistent results are persuasive evidence, students with divergent socio-economic backgrounds, reading levels, and experience have achieved significant improvement in knowledge of energy use.

Unanticipated outcomes and spinoff discoveries have shown that the EMC teacher training materials have a positive secondary effect on teachers because they provide a model for other teaching situations. More science is now being taught in the elementary classroom as a result of involvement with EMC materials. Parents are aware of the EMC project because students talk about it at home. Even students who seldom talk about school enthusiastically report their EMC activities. An immediate positive effect is noted with students categorized as disruptive, bored, or slow. When students are given the opportunity to work with their hands (often out-of-doors) and conduct investigations using an active approach, they seem to react with increased interest, participation, and academic gain.

The EMC elementary education materials have been successfully adopted by 35 school districts in Florida, and distributed to 39 states and at least three other nations. Since EMC programs for other grade levels are designed to to supplement existing classroom curriculum, they do not have the same impact on knowledge gain as the nine-week fourth grade program. For this reason, formal evaluation data have not been collected. However, surveys of students and teachers involved in the 5-12 grade energy programs indicate the programs are enjoyed and considered to be a valuable experience. High school classroom teachers use the EMC trip evaluation data as a laboratory or test score in their gradebooks.

Plans for Improvement

The health of the EMC program is directly dependent upon strong community and school board support. Because the programs serve a wide variety of students from a county-wide area, the background and abilities of the center's staff must represent a diversity of expertise; yet, they must be able to approach program development as a team. The present staff's broad interdisciplinary and multi-age-level experience contributes to their ability to provide the best energy curriculum possible.

All programs must be activity-oriented so students can receive as much hands-on experience as possible during their field trip. High level cognitive skills such as problem solving and analysis are stressed in the majority of EMC programs. The EMC staff must be able to quickly adapt all activities to the abilities of the students who participate on any given day. Alternative plans in case of bad weather must always be available.

The success of a program that combines classroom activities with field studies requires strong commitment from the classroom teacher or the field trip quickly degenerates from a learning experience into a field day. Such commitment can be influenced by inservice training and continuous communication between the center staff and the host schools. The classroom teachers must view the center staff as a valuable resource and the center staff must continuously update their skills and provide the most current materials and resources available. Involving the classroom teachers directly in the planning and development of any new programs also creates a feeling of ownership for the involved personnel.

Finally, the center staff must use the best methods of science teaching for their activities to be of any value to the students. Too often outdoor centers conduct field trips in such a manner that students are provided with merely a "show and tell" lecture. Field trip activities should emphasize the use of science process skills and actively involve all students. Worksheets, checklists, and reading assignments are best left in the classroom. Use the field experience to make the classroom studies relevant to energy, nature, society, and science. In this way students will have the knowledge and the skills to make intelligent decisions about energy use in their lives.

Chapter 5
Energy Education at Houston's Outdoor Education Center

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The energy program offered at the Houston Independent School District's Outdoor Education Center residential school reaches a cross-section of the fifth grade population in Houston as well as several other grade levels and visiting adults. We receive fifth grade students from 66 different schools each year.

Each week approximately 240 fifth grade students arrive at the Center. Our outdoor school is a part of the Houston Independent School District's magnet school program. We receive three different schools each week, one mostly black, one mostly Hispanic, and one mostly white. Our objective is to mix these children for an integrated living and learning situation. On several weekends throughout the school year we provide a similar educational program for junior high and high school students. We also work with adult groups. The center is located 100 miles north of Houston on a man-made lake, Lake Livingston. The lake was created ten years ago by damming up the Trinity River.

Because our program is residential, the staff is able to encourage desirable behavior from students both in class and at home. For example: we demonstrate how to conserve water and energy by shutting the water off while brushing teeth; we keep our thermostats low; we switch off lights when leaving a room.

The energy program is designed to present students with information and activities dealing with energy sources, energy development, energy production, and advantages and disadvantages of each form of energy including cost efficiency, environmental impact, and availability.

History of the Program

The Outdoor Education Center is a magnet school constructed eight years ago.

It was designed to be an outdoor extension of the classroom, to foster and promote concern for the environment, and to promote positive interactions between children of different economic, racial, and cultural backgrounds. The goals of The Outdoor Education Center are:

- To help students develop an understanding of basic environmental concepts and an appreciation of environmental concerns.
- To help students understand and appreciate the interdependency of one person to another, one culture to another, people with nature, things with nature.
- To be an extension of the classroom by reinforcing and complementing the efforts of the classroom teacher.
- To promote positive multicultural interactions through well-supervised, integrated, living-learning groups.
- To focus on the need for cooperative group efforts and the value of diversity.

Initially, our conservation activities dealt with water, soil, and habitat conservation. Energy conservation became part of the curriculum in 1979. Lessons were developed and activities were presented to some of the classes. Within a few months teachers became interested in energy education. Staff enthusiasm and the support from coordinators Tim Kempfe and Tom Cosper have been the most important factors of the program's success. The anticipation of a new hydroelectric dam nearby has also contributed to the inspiration of our energy program.

Student and Program Goals

The goal of the energy program is to increase the students' energy knowledge and understanding, to encourage students to be a part of the energy decision-making process, and to encourage the students to act as responsible citizens by practicing good energy conservation.

Our goals at the Outdoor Education Center promote a concern for the environment. Energy education goals are integrated into our curriculum. Our lessons have very little teacher talk and encourage students to probe on their own.

The effects of energy on our lives, economy, society, and the environment are key points of our lessons. In each of these we discuss past, present, and future uses of energy. In addition, we present activities to develop skills in energy use at home, school, and work; to illustrate energy resources, conversions, and resource limits; to illustrate community resources; and to show energy as a basic need. We try to help students understand human interaction with natural and social systems. In doing so, we stress that they need to understand themselves to make decisions which will affect the quality of life for all living organisms.

The entire program is interdisciplinary and satisfies district educational goals and proficiencies. Each teaching block deals with science, mathematics, social studies, and language arts. We stress the same concepts in each discipline. For example, we teach activities using the sun in the forest (including stored energy in trees and animals), in the garden (use of soil and plants), in conservation (better use of solar power will conserve other forms of energy), in math-compass (to find direction), in weather, and in other areas.

Specific Activities

Our energy curriculum is divided into four sections: different forms of energy available, energy practices and issues, the future of energy, and the citizen's role.

We present activities dealing with oil, coal, hydroelectric, nuclear, and solar energy as the major forms of energy presently used. As an introduction we discuss the resources needed to produce each of these five major forms of energy. We also discuss present versus past forms of energy use. Next we have the students make a list of how each uses energy over a 24 hour period. The lists usually include energy needed to have lights, to make breakfast, to take the bus to school, to watch television, and to run appliances like the refrigerator. Students usually don't include the energy used to pump water into their homes; to heat water; to run the washer and dryer; to create a comfortable living temperature by heating or cooling, to manufacture a bus for a ride to school; to operate the school building; to get the teachers to school; to make books, paper, pencils and supplies. They are amazed at our final list. After that we ask them to write a short story of what life would be like if we didn't have these conventional forms of energy or if we were to exhaust the supply. As a result the students realize that energy is a basic need and that it is essential in our homes, at school, and in jobs. They also conclude that we are socially and economically dependent upon energy and they are overwhelmed by the progress and change that has occurred in energy production.

Other activities we use that are related to this area of our program are reading electric meters, figuring out an electric bill, determining luxuries versus necessities with a KWH chart, watching energy films, and testing temperatures of different colored objects. Sometimes we have them construct a list of things they can do to conserve energy at home.

In our energy building (a one room building equipped with most of the materials needed for our energy program) we have posters that describe the conversion of each resource (coal, oil, water, uranium, and the sun) into electrical power. Some students dramatize a power plant; some play the role of the resources used, some play the turbines, and others become the electricity generated. It shows them how a power plant operates.

Also available is an energy relay game with five cans (one each for oil, coal, nuclear, hydroelectric, and solar) and four color-coded duplicate sets of cards with energy questions on them. One point is given to the first group to finish the relay and a point is given to the group that answers a question correctly by dropping the card into the proper can.

We use fact card puzzles. On one side of each puzzle piece there is an energy fact, on the other side there is a part of the word coal, oil, hydroelectric, nuclear, or solar. If the students properly group the related facts, the puzzle pieces will fit together and spell a form of energy. We also have photovoltaic panels which the students can hook up to radios and fans and experience the generation and transfer of electrical energy. We have volt and amp meters so they can determine how much energy output there is from each panel and how much is needed to operate different appliances.

All of these forms of energy create pollution in some way—even solar energy causes pollution when solar equipment such as photovoltaic panels are made. In our energy building we have a poster on pollution from different forms of energy and the students fill in the different types of pollution under the appropriate form of energy. We also have an activity where the student dips a feather into a can of water and then into a can of water with a few drops of oil in it. The students see the effects of oil spills on birds and how the feather barbs separate and become unzipped. We have a display of white socks that have been placed over exhaust pipes of properly tuned cars that burn regular gasoline, unleaded gasoline, or diesel fuel, and we also have a sock from a vehicle that was not properly maintained. The students write papers on the environmental effects of energy production, how they feel about it, and what can be done.

In our discussions, we ask if anyone in the class has a relative that works in an energy related field so that he or she might give the class a personal perspective. We ask if anyone uses solar equipment at home for the same reason. Then we ask who students could go to with energy questions. Most students say they would ask their teachers or write to the mayor. We have a list of people and places to contact for energy information which we make available to the students.

One of the most interesting parts of our energy program is the unit on energy practices and issues. It's amazing how much students learn from current events. We have students select an article from our current event file on world and U.S. energy practices and issues. Students read, interpret, and summarize their article and then explain its implications to the group. This is followed by a discussion. We

also write letters to government officials and energy companies for information and answers.

After activities on present forms of energy we deal with energy alternatives for the future. To begin, we discuss the finiteness of each form of energy and what we would do if we didn't have coal or oil and didn't live near a hydroelectric dam. We have a cassette recording called the "crisis tape;" it is a fictitious news bulletin about an energy crisis. Students respond to the tape by writing a story about energy shortages and their plans to live with less energy. They also write stories about how they plan to use energy in the future. Afterwards, we make a poster which lists energy alternatives such as wave, geothermal, fusion, wind, and solar. The students are always excited about this portion of the program.

We build on this excitement with examples of alternative energy use "in action." We are building a workable windmill and we have a solarium section in our energy building. We use skylights, large south-facing windows, and a southern building orientation to catch the sun's rays, an overhang to block the high summer sun, photovoltaic panels and storage batteries to run appliances, solar shutters for heating, a ventilating fan and a current-creating cooling chimney. We continually make additions to our energy building. We are presently reconstructing our recycling center adjacent to the energy building. We ask students to walk around the building and list the ways it uses the sun efficiently. Students enjoy deducing the energy functions of simple building features.

Students construct simple houses made from cardboard, paying special attention to planning, positioning, color, tree placement, window size and placement, and insulation. We give each group a thermometer to determine who created the best solar house. Another intriguing activity for the students is solar cooking. We have several types of solar cookers and ovens. The students enjoy cooking hot dogs, bread pudding with lots of honey and cinnamon, granola or chocolate chip cookies, and baked apples with raisins.

After students finish the energy program we ask them what they feel their responsibilities are, how their energy decisions relate to and affect nature, and how their decisions affect society. Students realize that they have the opportunity and responsibility to offer input.

Classroom Equipment

Most of our equipment and activities can be easily duplicated and used in a classroom. In fact, several teachers that have attended our workshops have already duplicated our equipment, lessons, and ideas.

Evaluation

The only way to understand how much the students enjoy the program is to see their interest and enthusiasm when they are involved in the activities. Their questions, discussions, and quality of work is impressive.

Radiometer (C)	Energy crisis tape (H)
Solar radio (C)	Recycled materials (H)
Energy relay game (H)	Oil on water game (H)
Energy puzzle game (H)	Patio cooker (C)
Solar flashlight (C)	Box oven (C)
Parabola cooker (H)	Solar cookbook (C)
Temperature can color game (H)	Cardboard ovens (C)
Solar hot water heater (H)	Solar vent fan and panel (C)
Box oven (H)	Volt and amp meter (C)
Hot dog cooker (H and C)	Storage batteries (C)
Fresnel lens (H)	Battery protector (C)
Demonstration fan cube (C)	Solar panels (C)
Cone cookers (H)	Solar shutters (C)
Energy posters (H)	Insulation display (H)
Energy books (C)	Demonstration houses (H)

(C) *Commercially made equipment*
(H) *Homemade materials*

Our evaluation procedures are short-term. We only test for knowledge gained during the week. We would like to develop a long-term follow-up procedure to evaluate program success, but once the students leave the center they return to one of 66 schools. We generally lose contact with them. Also, the energy program is incorporated into the overall environment education program and is usually not evaluated separately.

Plans for Improvement

Though our program is intense and reaches thousands of students each year, each student is involved in the program for only one week. While this is a limiting factor, we feel that we use the time available to the fullest extent. We would like to have a routine follow-up program for the students. In some cases fifth grade students return to our program when they reach junior high or high school. Still, we feel this is not enough and we are starting a follow-up program where our staff goes into the classrooms of schools which have participated in our program. We provide workshops, distribute information, visit schools, and act as a resource for the district, but we need to do more and to encourage more teachers to participate.

Now that the program is in operation and our materials are in good working order, our maintenance is low. The equipment is checked weekly for repairs or replacement. Our storage batteries have a battery protector to avoid overcharge or draining. Some equipment is delicate, and care is taken to keep the equipment in good condition.

Due to the nature of the residential program, the dynamics of the energy program, the support from the administration and the district, the interest of the students, and the enthusiasm of the staff, we feel that our energy program will continue to be a great success.

Chapter 6
The Energy Studies Center: Providing Skills for the Future

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Energy Studies Center
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As the largest school system in the State of Oregon, Portland Public Schools helps make Portland one of the most livable cities in America. The school district reflects the community's support for excellence in education and a spirit of cultural diversity, cooperation, planned growth, and innovation. A wealth of citizen interest in the city's future and its children provides a setting for maintaining high levels in education.

These factors coalesce to sustain a goals-oriented school program of more than 51,000 students and a staff of approximately 5000 teachers, administrators, and support personnel. The kindergarten through twelfth grade courses offer choices and challenges which enhance teacher skills and student competence.

The school board stays aware of the impact that national, regional, and local policies and events have upon the student population. They provide direction in developing curriculum and projects that will prepare students for the future.

With the advent of the energy crisis during the 1970's, district and other public agencies worked to cope with the impacts of supply and demand for resources with limited tax dollars. Response to the energy crunch from many directions and touched each citizen and student. School leaders believed energy education was an important component of the basic skills children would need to make informed, adult life choices.

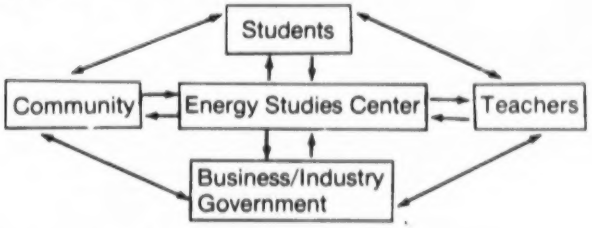
Out of this scenario came Energy Studies Center, a curricula-based central clearinghouse, training, and dissemination project created to mesh with other district elements. Reasons for providing the new service was detailed in a brief philosophical overview that gave administrators, teachers, and the community a rationale to begin designing the project. The justification for informing students and teachers about the complex issues that created America's energy crisis is as follows:

> The United States is struggling to cope with an energy problem, as outlined in a *Newsweek* magazine article (July 16, 1979) " . . . as grave as any America has faced since World War II—a national security issue of such scope and complexity that it is transforming the economy, threatening to destroy political consensus, and undermining traditional lifestyles."
>
> The realization that energy use affects the total spectrum of human endeavor presents problems that are not exclusively scientific and technical. Many of the critical decisions which must be made are political, economic, and social. Critical judgments require the public to be able to separate important information regarding facts, issues, and opinions. Surveys have confirmed earlier studies documenting a broad public illiteracy about fundamental energy facts, issues, and the trade-offs necessary to solve complex problems.
>
> The existence of energy illiteracy is a strong argument for the development of educational materials and instructional programs that will aid students and citizens in gaining the knowledge, skills, and attitudes needed to be competent participants in the resolution of energy questions. The use or misuse of resources and the long range impact of such choices requires that energy education be an integral part of public school curriculum. Only through a mainstream educational effort can students and teachers

receive the informational tools to begin searching for solutions to this nation's energy dilemma.

Portland Public Schools' Energy Studies Center is one approach to bringing energy literacy into the public school system. The increased understanding of energy issues will aid in stabilizing the region's resource requirements over the next 20 years, while the additional awareness will have a dramatic effect upon the economic, political, and social future of the Pacific Northwest.

From this thesis a project model was developed using district and community resources. Because the city of Portland was in the national forefront for municipal conservation efforts and is the corporate headquarters for several large utilities and the Bonneville Power Administration, we had assistance in constructing the educational curriculum component. All these agencies responded to the local and regional energy crisis at the time the Energy Studies Center was being developed. Additional assets came from departments of curriculum, staff development and training, audio-visual/ media, custodial, talented and gifted, and alternative education. The next phase in building the center was to adapt a simple model that would be broad enough to include the different groups/agencies in the community. The conceptual model can be viewed as thus:



In creating the Energy Studies Center, our attention was directed toward meeting or exceeding school district standards for educators and students. This decision dictated a mainstream approach that stressed student outcomes from kindergarten through the twelfth grade. To insure that energy did not displace a basic subject or become extra course work, all content and instructional factors dealing with energy concepts were carefully blended into the district-wide Scope and Sequence/Planned Course Goal Statements in science, social studies, home economics, industrial arts, and language arts. To firmly establish a direction for the project, a set of Energy Studies Center goals were necessary to integrate energy into teacher lesson planning. These goals have been modified over time to reflect changes in the curriculum department's role and currently are as follows:

- To increase energy literacy through integrated curriculum in the basic subject matter areas corresponding to district planned course goals and learning objectives.
- To increase positive interaction via energy education between students, teachers, community, business/industry, and government.
- To promote the wise and efficient use of energy and resources.

This set of guidelines allowed instructors the flexibility to bring supplemental materials into their classrooms in a logical, meaningful manner.

The Center's task was to identify, collect, and catalog lesson plans and resources for teachers to use during their yearly planning. After contacting various federal, state, regional, local, and national groups, an assortment of K-12 curricula was set up in a room in the model area high school. It was evident from the vast amount of energy education supplements available that the Center would not need to spend time or money to write or produce its own lesson plans. The overall quality of the outside educational tools was extremely high. The National Science Teachers Association, United States Department of Energy, United States Education Department, Energy and Man's Environment, Portland General Electric Company, and many others furnished usable, teacher-tested energy education units.

Extra care was taken to present the collection to teachers in a non-threatening way. The clearly defined role of the Energy Studies Center was "to assist and to support classroom teachers." To this end, the format chosen to disseminate energy literature was a series of workshops, training sessions, inservice courses, faculty/staff presentations, and administrative conferences. All of these meetings stressed the Energy Studies Center's function to make the teacher's job more efficient and productive. Two catch phrases were developed to pass this message to principals and faculty. The initial phrase was "At the Energy Studies Center, we put our energy into saving yours," and we recently adopted the line, "We Deliver!" Both were used on materials sent to teachers and administrators.

To start, the school board approved for implementation a limited one year, 10 school (K-12), model project. A grant award accompanied the proposed curriculum project. Energy and Man's Environment (EME), a national energy curriculum producer, sponsored a $13,000 matching cash grant for the 1979-80 school year for teacher training, materials, office start-up, and overhead expenses. Another $20,000 in EME energy materials was written into the grant. These funds provided an opportunity to take the teachers out of the classroom and train them for a specific role in a team of energy educators. This cadre was given the responsibility of acting as in-building experts on energy curriculum. The two full-day training sessions focused on current local, national, and world energy situations with the emphasis upon job description and use of curriculum.

This staff of building energy coordinators would give instructors support, encouragement, and a link to the centralized information center. Experience had shown that an on-site staff person with expertise would be far more successful in stimulating interest than a central office one-time visitor. To insure that these individuals would remain throughout the year and into the next, designated building energy coordinators were given extended responsibility pay as part of their regular pay, and received a detailed job description. The monetary segment of the plan was to show teachers that the district and granting agency felt their efforts were worth more than praise.

Remuneration is not the only unique feature; a strong part of the successful program is the close cooperation between district programs. Working with the talented and gifted department, the staff development department, or curriculum specialist has led teachers to hundreds of activities and thousands of classroom lesson plans. The networking section of the proposal was very effective in promoting energy education. An example of the impact on students

and teachers is a project from the district energy management team that saved the school system more than 4,185,000 kilowatt hours and helped reduce the budget expenditures by more than $183,000 over 18 months. These savings were the result of user awareness, internal department cooperation, and previous Energy Studies Center workshops. The team had no budget for training the large number of teachers and students. The center originated the electrical conservation idea and assisted with the implementation. The program was so successful that it was adopted by a local utility as "Project Kilowatt" for use in other school systems in the state.

The dramatic savings were possible because of close cooperation with non-school agencies. By contacting and informing a variety of groups about the Energy Studies Center's role, a network was established that teachers could call upon for assistance, classroom speakers, information, field trips, and more. To insure communication channels and a clear role for agency contributions, the Center provided a concise description of appropriate educational resources that could be used by instructors. In addition, the Energy Studies Center gave business/industry, community, and government bodies a single contact point. This proved helpful to these groups in identifying district expertise to assist their educational efforts. The Center was asked to be an information resource to several advisory/steering committees at the Oregon Museum of Science and Industry's TERA One Energy Center, the Eliot Energy House, Portland State University's Environmental Education Center, and other local projects. The Energy Studies Center was asked to assist state and local government agencies, private utilities, and energy suppliers as well.

In order to structure communication links between teachers and outside groups, all building energy coordinators attend monthly meetings featuring guest speakers from the community, businesses, and industries. Here the coordinators learn about new services or data, and share their impressions with other coordinators. This cross-talk stimulates new ideas and educational tools. They have produced an energy audiovisual catalog of district films, a speakers guide, field trips site list, numerous building activity formats, and much more.

The close-knit group of 10 building energy coordinators ended the first year with hundreds of activities and accomplishments involving students, teachers, parents, and the community. Events included a beginning workshop in each building, a press conference, field trips, speakers, and poster art shows.

With the success of the Energy Studies Center during the initial year, additional funding from Energy and Man's Environment opened the way for expansion to 21 new schools. Each school principal selected a coordinator and another training session was held. Due to the expanded size of the building energy coordinators group and the geographic area covered, it was vital to maintain strong lines of communication. Regular monthly meetings were necessary to reduce paper work, reinforce model behavior, share new data, and present a unified direction.

The 1980-81 academic year was highlighted by several events including a large inservice day energy workshop for over 120 teachers, smaller Energy Studies Center workshops, faculty/staff presentations, speakers, Energy Month, special student programs such as the Community Conservation Project Conference, and dozens of classroom/building activities involving more than 2,800 students. Because of the increased number of teachers aware of its activities, the Center moved aggressively to acquire more curricula and library references. Neighboring schools districts and the general public began to request materials and information from the Energy Studies Center.

The Energy Studies Center and the Portland Public Schools Television Services produced a series of short public service announcements and energy conservation tips. These spots were aired on local channels over a three month period. Another community oriented segment was the development of an energy fair. The idea was to bring various city, regional, and state agencies and companies to a single location for a citizen's workshop about conservation ideas, programs, and possible financial arrangements. This format proved successful and was adapted by a number of agencies involved in the first meeting.

As the 1981-82 school year began, Energy and Man's Environment again supported the Energy Studies Center with a cash and materials grant. Additional funds were raised through the combined efforts of the city of Portland, Congressman Ron Wyden, and the United States Department of Energy. The persistent work of Portland City Commissioner Mike Lindberg and his energy office director, Jeanne McCormick, helped acquire a $35,000 grant. This grant permitted the expansion of the model area during 1981-82 to include 44 schools and the hiring of a half-time assistant. Gene Meyer, a building energy coordinator, was selected to fill the position. His expertise brought a wider range of program planning; development of special in-building visits with both building energy coordinators and teachers, called one-on-one mini-sessions; and greater flexibility in meeting teacher requests for workshops.

By the end of the 1981-82 school year more than 16,700 students had been part of classroom energy activities. More than 1,080 teachers had taken part in workshops; 720 teachers had used energy lesson plans in their classrooms. Most classroom work was part of a minimum three day unit with the average unit lasting more than a week.

Notable events included a talented and gifted workshop at Lewis and Clark College, low income heating assistance through Project Warm, hundreds of classroom learning situations, Energy Month, and an invitation to attend the Fourth Annual Practitioners Conference on Energy Education sponsored by the National Science Teachers Association. The energy project was included in two films, one by Twentieth Century Fox and the other by a Japanese documentary film crew. An offshoot of one of the poster shows was a student's design of a light switch sticker that was attached to every light switch plate in 98 school buildings to remind everyone to "Think bright, turn off the light." Student participation reached new levels when high school and middle school students were invited by elementary schools to teach the younger students about energy concepts. Response from the elementary teachers was overwhelmingly positive and the children loved the big kids. This was the first indication that the energy project was becoming self-sustaining through individual teacher initiative.

One example of a new idea is the Good Cents Industrial Arts Construction module at the high school level. Stu-

dents will have the opportunity to construct a super-insulated 1,500–2,000 square foot home. The house will have 10 specific features including passive solar energy and computer assisted heat loss. Industrial arts, drafting, and construction/design teachers will build and sell the home through a grant from Portland General Electric. The house will also serve as a field trip site for students and teachers in grades 4–12. With the emphasis upon improving building codes from the Bonneville Power Administration, plans like this one benefit a large segment of the population. This will be the first of its kind in the state and will be a model for other utility/school partnerships interested in adding to their industrial arts programs.

By taking an active role in local community, business, industry, and government concerns, the Energy Studies Center will continue to promote energy education for the city's future adults. The measure of success will be determined over the next 20 years as a greater awareness of energy issues confronting us helps us make the difficult decisions. Portland Public Schools believes that citizens must not be dragged along the road to resolution, but must have the knowledge and wisdom to actively participate in future choices and decisions. Children must understand the concepts inherent in making critical judgments, as they have a personal stake in the outcome. The abundance of resources will continue to affect every aspect of their lives.

Between 1982–84, Portland Public Schools took full financial responsibility for maintaining the expanded program. A series of "Make-n-Take" workshops were added to the menu of services. The format for the "Make-n-Take" series was based upon a survey randomly distributed to more than 250 teachers with a choice of topics and activities. Roughly 35 percent of the teachers responded and the top six topics were used to form the series. The workshops were well attended and geared to K-8 grade teachers. Each teacher left the session with a packet of lesson plans—two or more of which had been created during the workshop—along with posters, stickers, references, and at least two projects. Teachers constructed flat plate collectors, water wheels, draft-o-meters, insulation rating meters, model solar homes, photovoltaic music boxes, anemometers and more. All of the devices were designed for use as demonstrations or as finished products for students to replicate in energy projects.

A reflection of the success of the Energy Studies Center came in the summer of 1984 when the State of Oregon awarded Portland Public Schools the Governor's Energy Award for Outstanding Achievement in Energy Conservation. In September, the school board learned that the United States Department of Energy had awarded the Energy Studies Center with its National Award for Energy Innovation. These honors underscore the effort of Portland Public Schools, the City of Portland, and numerous community and private agencies to make energy education a strong part of the main-stream, basic skills approach for students and teachers.

Evaluation

The process of evaluation uses input from teachers, building energy coordinators, principals, and the community. Several tools are used, but the survey method has proved to be the most useful. Evaluation surveys are sent randomly to principals in model and non-model schools. Their responses have been highly favorable and have included many useful comments and suggestions. Another set of surveys are sent randomly to teachers within and outside the model area. These questionnaires contain comments, suggestions for improvement, and ideas to help teachers in the classroom. The most thorough evaluations are required by the building energy coordinators. The seven-page questionnaire covers every aspect of the program from goals to performance. By documenting the number of students and teachers using its materials, the center can measure the effectiveness of the delivery system. The composite evaluations demonstrate that teachers, principals, and students like the program and find it worthwhile. The central administration and school board have confirmed these findings by moving to continue the program on a year to year basis.

A final test for the program is the ability to sustain outside funding to improve internal systems. Recently, another grant award from Portland General Electric Company launched a new phase within the Energy Studies Center. Representatives from both the public and private sectors have called for continuation of the center. Letters of support from Congressman Ron Wyden, the Oregon Education Association, City Commissioner Mike Lindberg, and others verify the need for continuing energy education.

Plans for Improvement

As the school district adopts new textbook and reevaluates planned course statements, energy education has become a permanent fixture in the curriculum. The district commitment is strengthened by high visibility and outside support. Without local support, no project would be able to sustain a viable program for any length of time. New ideas and practices will be sought from the teachers and community to attract and service target audiences.

Chapter 7
Poss's Energy Posse

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Wallingford, Connecticut, is a suburban community of approximately 37,000 people surrounded by a large and diverse base of industries. The majority of students come from blue collar families that are supportive and appreciative of the efforts of classroom teachers.

This energy project evolved as part of the K–5 Career/Consumer Education Program of the Wallingford Public Schools. As part of becoming wise consumers, students must begin early to understand energy costs and choices. In addition, there are multiple careers to explore that are directly or indirectly related to the field of energy.

The program was designed to minimize costs. It drew upon a variety of existing resources, including textbook materials, films, activities in the Connecticut Council for Teachers newsletters, free presentations by personnel from the Connecticut Yankee Nuclear Power Plant Visitors' Center, physical and financial support from our local Energy Office and Board of Education, and help and ideas from Wallingford businesses involved in the energy field. The Wallingford Auditing Technical Team (WATT), an active group of high school students, also provided ideas and manpower for some of the larger activities. The major resource, however, was OccuPossum.

OccuPossum is the puppet who helps teach Wallingford youngsters about the world of work. Poss usually visits the classrooms dressed in the work clothes and gear of different workers. Primary students guess OccuPossum's occupation, while upper grade students identify the career cluster to which the job belongs. For this project, Poss donned his sheriff's outfit, grabbed his caulking guns, and "rounded-up" Poss's Energy Posse (PEP).

Our Program

Our goals for teachers and students include:

- To develop an awareness and appreciation of the role energy plays in our daily lives.
- To develop a sense of responsibility toward minimizing personal consumption of energy.
- To actively seek ways in which energy could be saved at school.
- To explore the many careers related to energy.
- To use our studies to motivate learning and enrich the curriculum areas.

Our plan was to provide a framework of energy activities and themes in which teachers and students could develop their own activities and resources suitable to the grade level and the teacher's preferred teaching style. First, Sheriff Poss deputized the students as members of Poss's Energy Posse. Primary students were referred to as deputies and upper grade students as rangers. Different activities and experiences were developed for these different levels, as well as shared events and experiments.

Each posse was escorted on an Energy Round-Up tour of the school buildings to locate where and how energy was used/abused. We found Energy Rustlers, Heat-Loss Harry, 'Lectric Looie, Drippy Dora, and Junk-Food Jane to name a few. The Coal Boys, Solar Sals, and their gangs provided themes of study in energy alternatives, conservation, and nutrition. Each of these themes serves as a topic for language arts and mathematics.

Soon bulletin boards, table displays, energy experiments and other activities began appearing in the classrooms. Poss

is often invited to view and/or participate in numerous events. Each class is unique. Representative class activities include:

- One PEP class sent letters home requesting to "borrow some garbage" from their parents. These contributions were ceremoniously buried with the Halloween pumpkin. Later, in the spring, the "garbage" was returned to the students' parents with marigolds growing in it.
- Another group used a ditto of Poss's mobile as the base for a nutrition unit. This mobile, with such themes as "The Sun Makes Butter" and "The Sun Makes Ice Cream" included a mural showing the chain of energy from sun to human consumers.
- A leaking faucet (Drippy Dora) inspired the study of "Energy Makes Math". Students measured the water loss per hour, then computed the loss and cost per day, week, month, and school year. Letters to the school system maintenance department resulted in children observing a plumber at work—another tie with career education.
- A doll house provided a study of auditing for a selected group of second to fifth grade students. Students from the Sheehan High School WATT demonstrated how and why homes and other buildings were checked for efficient use of energy. The elementary students then shared what they had learned with their classmates. A team of fifth grade students used the doll house at our fair to demonstrate alternate energy sources. Licorice was used as weather stripping; different samples of insulation were displayed; and simulated solar panels were explained.
- "PEP Cornomics" was the extensive unit of study by second grade students at Cook Hill School. It spanned subject areas from art and music through map and language skills, reading, mathematics, economics, and science. The youngsters made and sold popcorn and computed costs, losses, and profit. The money from the sale was used for a bus ride to Pond Hill's Energy Rodeo.

An energy fair was the natural and inevitable follow-up to all the excitement. This provided an opportunity to share different levels of study with our schoolmates and parents, as well as with other interested community members. Sheriff Poss invited the posses to join in an Energy Rodeo. Numerous activities are conducted at our rodeo. We have our doll house display of alternate energy sources. "Energy in Toy Land" provides a collection of powered toys. A wall display of jailed Energy Rustlers with oral explanations of their crimes is given by first grade students. A game of Pin the Star on the Sheriff is played by all students. All students and guests enjoy our graffiti board entitled "Our Bright Ideas on Energy . . . What's Yours?"

In order to keep the western theme, guests and students in kindergarten through grade four are invited to come dressed as cowboys. Fifth grade students are living displays; some come dressed as My Career in Energy electricians, geologists, miners, and nuclear engineers. Others come dressed as Energy in my Career. These students dress as teachers, hair stylists, truckers, and baseball players with explanations of the kinds of energy used and the impact that scarcities might have on these careers.

Evaluation

One of the greatest strengths of the project was the enthusiasm for learning. Teachers remarked that they appreciated the framework that gave them the opportunity to explore new ways of using science and other curriculum areas and resources. Parents said their youngsters carried much of the interest and excitement home and they appreciated the concern to conserve. Students are eager to continue the study and plans are set to hold Energy Rodeos for five of the seven elementary schools in Wallingford this year.

Plans for Improvement

The entire community was delighted when the project received CEED (Connecticut Energy Education Day) and NEED (National Energy Education Day) awards. The Search For Excellence in Energy education added to our delight. We hope to develop a book and a teachers guide; our local Energy Office has expressed interest in publishing these materials. These publications would allow us to share our experiences with other school systems more readily. Presently, handouts and activity sheets are available . . . the POSSibilities are unlimited.

Chapter 8
Toward an Energy Consciousness

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Located in the heart of the greater Seattle area, Renton is the eleventh largest city in the state of Washington. With a metropolitan population of 75,000, the community is primarily white, suburban, and middle class. Boeing and Pacific Car and Foundry form the major industrial focus. Renton is near almost every type of industry, sports, entertainment, cultural and intercultural opportunity, and educational institution. Skiing, fishing, camping, sailing, and backpacking are less than an hour's drive away. Renton has the amenities of a major city, yet people can get away from the crowds.

The Renton School District has an enrollment of just under 13,000 students in grades K-12. There are three high schools (grades 9-12), three middle schools (grades 7-8) and 13 elementary schools (grades K-6) As of October, 1984, the school enrollment was 80.7 percent white, 7.6 percent black, 7.7 percent Asian or Pacific Islander, 2.0 percent American Indian, and 2.0 percent Hispanic.

Prior to the 1970s, elementary science had a varying degree of emphasis; teachers with an interest and background in science took the initiative to develop class projects; others stressed language arts, mathematics, or reading. After experimenting with several commercial programs, we decided to develop our own program. The initial phase of our science development program began in the early 1970's. Teachers and parents were surveyed to determine appropriate topics for each grade level. From this survey the science topics and concepts for each grade level were determined. Under the supervision of the ad hoc science coordinator, program development and writing started in the mid-70's. We decided that one kit at each grade level (4, 5, and 6) would be integrated with a district sponsored field trip.

The design phase of our elementary science program coincided with the gasoline shortage of 1973, the natural gas shortage of 1976, and constantly rising fuel costs. It became apparent that people must learn to regard energy as a precious resource. We determined that part of the fifth grade curriculum would include an energy science unit. By augmenting the energy unit with a field trip, we hoped to develop pervasive energy consciousness in our students. The field trip provided an avenue for teaching energy objectives not possible, in the classroom and complemented the science unit objectives. This energy unit provided us with an opportunity to help students realize that their energy-related decisions will affect lifestyles, quality of life, and economic well-being.

In 1977, Renton School District established the position of elementary science program assistant. This new resource person had the responsibility of developing field trips and curriculum material with the assistance of the ad hoc science coordinator. Concepts, goals, and objectives were outlined for the new energy unit, and supporting lessons and new activities were designed to teach them. After a month of writing, the new study guide was field tested with teachers and students and was revised as needed. In the winter of 1977, teachers received inservice training and implemented the energy unit the following spring.

The development of the field trip agenda was preceded by the compilation of a list of community resources and potential sites. These resources and sites were assessed to determine distance, time, cost, availability, and ability to

meet goals and objectives. In coordination with the local utility, Puget Power, a one day field trip was planned. The elementary science program assistant established schedules, arranged dates and buses, and provided instruction for the day.

Our Program

The entire K-6 science curriculum has a hands-on approach to science education that provides concrete, first-hand experiences. We also use a kitchen science philosophy to program implementation—science should be a positive everyday experience and not an isolated experience in a laboratory.

The fifth grade program, energy and electricity, reflects this philosophy. The units have been developed to promote an interest in life science, earth science, and physical science. There is a progressive development of energy concepts in supporting curriculum at grades 2, 3, 6, and 7 through 12. Energy and electricity is an intensive five week science study unit. Each year 35 to 40 teachers present the energy unit to approximately 1,000 fifth grade students. The classrooms are conventional; each elementary school has two to three fifth grade classrooms with 28 to 30 students. Each school receives a complete energy kit with materials needed to perform the activities. Materials are grouped into bags that coordinate with individual lesson plans. Transparencies for teachers and activity sheets for students are included. Supplemental materials are available for checkout from the district's science resource center. The master list of the kit materials includes:

15	Hard rubber combs
1	Bottle cleaning solution (for combs)
4	Plastic sandwich bags
2	Balloons
15	Cork stoppers (with hole)
1	Box paper clips
	Tinsel strands
17	Batteries
15	Battery holders
30	Battery clips
17	Light bulbs
15	Light bulb holders
15	Sandwich bags, self-closing
15	Iron nails
15	Pennies
15	Aluminum foil strips
15	Rubber bands
15	Uninsulated copper wires (3" pieces)
15	Corks
15	Wood sticks
70	Insulated copper wires (8" pieces)
2	Electromagnets
15	Switches
15	Compasses
15	Copper wires (8' long)
1	Mock electric meter
1	Demonstration meter
1	Working meter
5	Transparencies

Our district science program intends students to:

- Master, maintain, and apply the basic facts, concepts, skills, and processes associated with science.
- Develop positive attitudes towards themselves through their relationship with science.
- Gain curiosity, initiative, creativity, and objectivity.
- Gain understanding and respect for the environment.
- Develop fundamental skills in manipulating laboratory materials and equipment, and in gathering, organizing and communicating scientific information.
- Develop a knowledge of and a respect for the past contributions, the future possibilities, and the existing limitations of science in solving societal problems.
- Develop and reinforce study and academic skills taught in other areas of the curriculum.
- Acquire an understanding of the relationship of science to everyday living and various occupations.
- Develop rational thinking processes which underlie the scientific approach to problem solving.

For example, the energy and electricity science program is a two-part unit that encompasses five weeks of intensive work. The unit is part of our core science program that is a required science curriculum. The initial phase is a classroom package designed to spark concern in students.

The energy and electricity kit is a large plastic tub containing all the materials needed to carry out the hands-on activities in the teachers' guide. As in all the units, materials in the energy and electricity kit are grouped into bags corresponding to each lesson plan.

The lesson activities are planned so that the students use process science: observing, classifying, measuring, collecting and organizing data, and ultimately predicting and inferring the outcomes of specified events. All children become actively involved in the investigations either in small groups or individually. They record pertinent data and follow-up by making generalizations and drawing conclusions. The program is not only science; it incorporates mathematics, language arts, social studies, and fine arts skills.

The first lessons of the energy unit emphasize the nature and importance of energy and energy sources in our lives. The next lessons examine electrical energy and how and why it works. The concluding lessons examine the impact of electrical energy in our lives and the role of alternative energy sources. Through these lessons, students become aware that the energy problem is a human-made problem and that there are alternatives to our present predicament. The lessons and activities help children see that in a world teeming with alternatives, people, as individuals or in groups, must chose their solutions carefully.

There are additional resources to augment the energy unit. The district's film library has designated 11 films and two filmstrips to be used in conjunction with the lessons. Reference books have been added to our district's professional library. Various local electric and natural gas public utilities provide materials and in-class energy education programs. The background provided by the lessons, films, books, and speakers has allowed the students to experience discovery, small-group decision-making, and the process of, drawing conclusions based on their research. They are familiar with data gathering tools, materials, and techniques. With a solid background of energy information, students go on a field trip.

The field trip is a full day that allows students to observe and experience the concepts and processes developed in the lesson plans. A specially trained resource person accompanies each group on the field trip. This individual possesses a broad knowledge base and provides instruction and coordination for the day. Students are accompanied on the trip by teachers and parents; classrooms are divided into working groups of seven or eight students and an adult. Each student is given a field trip handbook with resource information, activities, and materials.

Below is a time schedule for the day's activities with the accompanying concepts for each phase.

9:00–10:00	Travel to Snoqualmie. Travel time on the bus is used as instruction time.
10:00–10:45	Tour of hydroelectric plant. An education specialist from Puget Power conducts this part of the program. He/she uses a variety of large visual aids and working models of generators to describe the operation and energy production of the plant. Students tour the plant.
10:45–11:45	Hike to Snoqualmie Falls. We stop at designated points along the trail to view the parts of the hydro plant from different perspectives. We discuss the history of the area and how the pioneers lived without the resources we have available today.
11:15–12:30	Ride to park and have picnic lunch.
12:30–12:45	Shuffleton Power Plant. This is a diesel fired power plant used only in times of cold snaps and brown outs. We learn how and why it works, compare it to the hydroelectric facility we observed earlier, and discuss why alternatives are important.
1:00–2:30	During an auditorium presentation, we have an open discussion of energy needs, oil reserves, and our need for conservation. Students then watch a film "The Energy Seekers" which shows alternative energy resources and the need for conservation. After the film the students, in small groups, visit 10 learning stations. Each station describes an energy resource with its associated advantages and disadvantages. Students leave for school with a home energy audit they can use to take an inventory of their home's energy conservation potential.

Evaluation

We would like our evaluation system to reflect our student goals. The nine student goals listed previously have been grouped here into five categories for simplicity. Several goals are qualitative observations and difficult to measure.

- *Encourage a positive attitude toward science.* Evaluation of attitudes is not easy. Attitudes however, are usually manifested by behavior. By observing behavioral responses it is apparent that the program is well received by students. Comments included, "we should do it again" and "it's even better than recess."
- *Participate actively in science.* The design of the program makes it difficult not to succeed in this area. The unit is centered around student activities. . . . "I wish we could learn like this all the time" and "we're doing something" are often heard.
- *Raising curiosity and level of inquiry.* Children have a natural curiosity. We hope that by guidance and planning we can use science as a tool for intellectual development. By responding to students' questions with additional thought-provoking questions rather than pat answers we hope to accomplish our goal. This is an intuitive evaluation on the part of our teachers and not a quantitative one.
- *Become scientifically literate.* Though this can be measured quantitatively, we have just begun to take formal steps to do so. Until this year science has been graded on report cards as pass/fail. Evaluative tools consisted mainly of teacher observation of student cooperation, attitude, and skills with materials. Evaluation was also based on teacher-made tests and teacher assessment of student projects. This year was the first year of graded science. We are developing standard objective referenced tests. This past summer saw the design of a standardized pre/post test to evaluate how well the program achieves its goals. This predominately multiple choice test should reflect learned facts and concepts.
- *Develop problem solving skills.* Although this is a difficult area to evaluate we are presently considering various approaches. We hope this will not be a pencil and paper test, but an actual activity. Using a model situation, students should be able to discern the nature of a problem, design an investigation, and ultimately arrive at a solution. Manipulating and interpreting data will be an important part of this evaluation. This study will provide a foundation for further scientific study and developing advanced skills. Most importantly, it should provide problem solving techniques.

The design of student evaluations is coupled with constant teacher feedback. We are always monitoring teacher opinions, attitudes, and success with the unit. Teachers are asked for comments on kit materials, lesson plans, concepts, films, and support materials. Each year all teachers submit a field trip evaluation form.

Through student and teacher evaluations, the science kit, and field trip are constantly evaluated and revised to assure its high standards. A typical teacher comment: "With the kit and the field trip, I'm sure my students think I can teach science. Keep up the good work. You are making us look like scientists!"

With feedback from evaluations, Puget Power has been most cooperative in modifying their part of the program to better meet student needs. For example, it was difficult for the students to visualize the actual working parts of the large generators. Puget Power now has a hand magneto-generator for students to crank and a 3 x 2 x 4 foot working model of a generator that is water-powered and enclosed in plexiglass. Students can now observe the water flow, turbine blades, and shaft.

Plans for Improvement

There are several key factors that contribute to the success of this program.

- *Field-tested and in-house developed materials* Our curriculum is developed by our staff and tested in the classrooms. Constant evaluation and revision improve the quality of the

program. By development and testing within our own district we have been able to develop activities and lessons that incorporate our teachers' needs and unique styles.

- *Activity-based science* A variety of manipulative materials are used in the program. Lessons build on each other and reinforce skills in language arts, social studies, reading, and mathematics.
- *Centrally prepared and restocked science kits* Each science kit is built and restocked by a full-time person in our science resource center. A central supply assures that the kits are complete and up-to-date.
- *Competent, cooperative teachers* Beginning with the very first kits, we have conducted teacher inservice programs for content and process. We provide individualized inservice programs for new teachers or teachers changing grade levels so that the teachers maintain a degree of confidence.
- *A resource specialist* A person with a strong science-energy background is a key to the success of the field trip. This person provides consistent coordination and instruction on the field trip.
- *Local energy production resources* We have a hydroelectric plant and public utility willing to provide us with speakers and a tour of their facility.

If any of these items were weak the whole structure would not be nearly as effective. We have several areas we would like to improve, some attainable, others not so attainable. We are hoping to obtain larger classrooms with running water, portable partitions, carpeted areas, and a science room in each school. In addition, we need more effective evaluation tools, more supporting computer software, and better inservice programs. More time per week for science is something we are striving for.

Our teachers need a better background in the problem-solving skills and the art of questioning. Teachers feel hampered by their lack of science background. Increasing college requirements in science may help this. But teachers must also realize it is not bad to say "I don't know. Let's find out."

Chapter 9
Energy Studies and Physical Sciences

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The town of Lexington has a tradition of valuing public education at all levels for all students. Community pride and involvement in the public schools is evident in many ways including financial commitment to excellence in education. The town has approximately 4800 students in grades K–12, and 420 teachers. The per pupil costs are approximately $4000 with teacher/student ratios of: elementary 1:24, junior high 1:15, and senior high 1:16. The student population covers the spectrum from high achievers to special needs students. The school system participates in the Metco Program of voluntary busing of approximately 280 inner-city minority students in grades K–12.

The atmosphere in the school system is conducive to initiatives and innovations developed and practiced by its teachers. Faculty are highly professional and mutually supportive. Morale is high. Interchange of ideas among the faculty is part of the fabric of the system, and there is ongoing administrative support of programs. Classroom visits are frequent and generally supportive.

Science is a respected area of study in Lexington. There is a commitment to participatory laboratory science and to a quality science experience for all levels of learners. Textbooks are not required. Science classes are taught in science laboratories. The science department budget has not been reduced despite setbacks in school funding.

The science curriculum for the junior high schools in Lexington has a physical science core at the eighth grade level. The curriculum evolved as a test center for the development of the Introductory Physical Science (IPS) program. Emphasis is on laboratory investigations which require collecting data, recording, analysis, and interpretation of data. Students are expected to gain confidence and competence in the laboratory. They learn that matter can be manipulated, separated, tested for properties, and identified by those properties. They learn to function with a level of freedom, cooperation and responsibility requisite to a laboratory setting.

The eighth grade science teachers combine an awareness of the cognitive and emotional development of early adolescents with a belief that science should be experienced. They believe that science is relative to quality of life, and that it contributes to decision-making ability. They know that to catch an early adolescent's attention, science must be interesting and students should associate science with their own experiences.

Initially, eighth grade teachers noted numerous connections between energy studies and physical science. Ideas and classes were exchanged, units shared, and an energy studies/physical sciences course was developed. We were unsatisfied with the ratio between student laboratory activities and teacher presentation time, so we expanded the number of energy activities. We initiated industrial contacts and took our students on field trips to various energy related industries. We identified sources of energy related films, some of which we use to help students evaluate presentations.

Using the Oakridge Science Activities in Energy (SAE) as a starting point, we invited students to devise their own energy related projects for the original "Earth Day" and we joined the high school Earth Day activities. The eighth grade students dominated the event with their voluntary energy projects. Each year we have added to our files of

energy project ideas and "starters," filling several loose leaf notebooks.

Since 1979 we have held our Energy Expo day at Clarke Junior High School, inviting all seventh and ninth grade students to join us on the school lawn. The quality of the projects has improved as the teachers refined their approach and shared past projects with present students. The Energy Expo is the culmination of the year's science studies, incorporating physical science and laboratory/research skills to investigate energy use. Student success is built into the experiences; even recalcitrant learners blossom when given the chance to use manipulative skills.

We have used summer curriculum workshop time to review the energy curricula we have tried and to identify and test energy activities for use in the physical science course. We identified the appropriate National Science Foundation program that could help us accomplish our curriculum development goals. With the cooperation of the Lexington Public Schools we developed a consortium with Boston University and received funding from NSF for two projects in which we trained other New England teachers to identify energy activities to include in their courses. Of the hundreds of science teachers developing and working with energy activities, we identified activities that best fit our curriculum.

Our students were invited to lead third grade students in our school system in energy investigations. In the last few years we have shared our infusion model and energy laboratories with teachers across the country. Community awareness and cooperation continue to grow as student activities and energy awareness affect families and neighbors. Area residents and industries have contributed time, materials, site visits, expertise, and resources to our program. In the last two years we have developed and refined our teaching strategies for helping students deal with social issues and decision-making.

Our Program

We chose to use energy sources and uses as a model for students to experience the interdependence of science with other disciplines and its effect on the quality of life. The incorporation of energy topics makes physical science topics even more relevant, useful, and interesting to students. They learn that science helps to explain much of what happens in life. Energy use choices provide a model of the advantages and disadvantages that accompany choices in life. Making decisions based on available facts may eventually help students make ethical decisions about more complex environmental issues. By focusing curriculum content on real energy problems, students gain insight into local, national, and international affairs. They can see the connections between science, technology, and society.

The energy studies and physical sciences program has been accepted as a major component of the science program for all students. Faculty in other disciplines often identify areas of interdisciplinary cooperation where energy/science/society issues in the science course can provide vehicles for student growth in other subject areas. Teachers in other subjects report positive impact on their program by the energy program. Returning high school students and their parents often include the energy studies as one of the highlights of their junior high experience.

Plans for Improvement

One sign of a program's effectiveness is its continuation in the absence of one of the program's creators. The energy studies and physical sciences program passed that test when one of the original teachers took a sabbatical for graduate study. With such a stability indicator the continuation of the program seems highly probable.

Like the human beings involved in the program, the program continues to grow. Because the curriculum grew out of a search for better ways to meet the educational needs of students facing twentieth century citizenship, the program will continue to be open for growth. That growth is verified by the increasing number of connections to other disciplines.

The weakness of the program is with intergrade level articulation. Continuing the elementary school visitations by the junior high energy/science students should improve continuity in the lower grades.

Interdepartmental curriculum work in energy studies is also weak. Department curriculum is considered in a K–12 sequence for each department. More time for curriculum development and encouragement for interdepartmental studies should be encouraged in the school system.

Opportunities for continuing professional growth for teachers is essential. The program evolved from ideas and experiences shared in a local and national network of professional contacts. Without exposure to people and ideas, teachers' enthusiasm will be drawn upon but not replenished. The nature of the energy studies program requires a high energy input on the part of the teachers.

The energy studies and physical sciences program at Jonas Clarke Junior High School is a dynamic infusions model which fits most existing curriculum situations. The program provides long term study of energy. The model encourages continued growth of an activity-oriented, realistic, responsible energy education program.

Students must evaluate information. They begin to recognize that well-considered conclusions may vary from person to person. They work in a framework where they can see that science does not always provide the right answer. They learn to respect each others' conclusions even though they differ. They discover that conclusions must be tentative. Using information responsibly to improve human conditions is an underlying value in our science program.

By focusing on real life applications and decision-making experiences, we seek to show students the responsible use of knowledge. We use an infusion model to give us the time to develop student energy awareness, decision-making skills, and personal energy ethics. Our model allows for "covering" physical science content but also provides an environment for dealing with energy. For example, we study fractional distillation as a separation process early in the year when we study petroleum issues.

Just as physical science content serves the energy source being studied, the energy source dictates new course content. The electromagnetic spectrum was not a part of the original IPS course content. It was added because absorption and reradiation must be understood in order to comprehend solar energy and the greenhouse effect.

More than 80 percent of student time is devoted to laboratory activities. Since we do not rely on fre-

quent use of student texts, the energy activities are taken from a large array of sources. Our energy curriculum library is substantial.

The energy studies require students to develop eight reports based on structured outlines. The report writing requirement consititutes a "need to know" on the part of the student. Student resources for the reports include periodic presentations by the teachers, class discussions, the student energy text (*Energy and Our Future*, Oxenhorn, Globe Book Co., 1979), library resources, television videotapes, parents, and community resources. Energy studies covers fossil fuels, electricity, nuclear fission and fusion, solar, hydro, wind, tidal, biomass, and conservation.

At the end of each energy source unit, each student defines and considers a social issue, and a personal resolution of the issue with acknowledgement of the trade-offs involved. Students often have difficulty accepting disadvantages as a necessary part of a choice.

The student projects at the Energy Expo are the culmination of the year's study of energy and physical science. Students design their own experiment and/or demonstration. They prepare an experimental proposal. When the proposal is approved by parents and teacher, the project is developed following the format of their laboratory investigation reports. All projects are demonstrated on the school lawn and final data are collected. All students submit their reports to their "funding agencies" (teachers and parents) for evaluation. Since there is no competition among students, success is within each student's reach. Each student can test their skills and gain self-confidence.

Evaluation

Program evaluation is based on a mix of evaluations of student process skills, products, attitudes, knowledge, and use of knowledge. Evaluation ranges from lower order cognitive skills used for acquiring knowledge to transitional and higher order cognitive skills requiring manipulation of knowledge for producing (1) daily energy laboratory reports, (2) monthly energy source/uses reports with social issue analysis, and (3) Energy Expo experimentation and accompanying reports. Other demonstrations of skills include: new products and activities, a conservation commercial for a local radio contest, conservation posters, interviews with community members for energy report information, and identifying information sources and evaluating them in terms of their objectivity or bias.

Chapter 10
Excellence in Teaching Energy Education: A Critique

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The field of energy education is relatively new in schools. Little attention was given to the supply and use of energy resources in the school curriculum until the Arab oil embargo and rapidly escalating energy prices of the early 1970s. The first use of energy education as a descriptor by the Education Resources Information Center (ERIC) was in July 1978. When this search for excellence in teaching energy education was conducted during the 1983-1984 school year, many well developed programs were identified. It appears that rapid progress in program development had been made; much, however, remains to be accomplished. This chapter describes our progress and outlines our tasks at hand.

In chapter 1 of this monograph, members of the Task Force Committee for Defining Excellence in Energy Education describe the nature of the desired state of energy education. The authors drew from their own experiences, findings reported in the energy education literature, Project Synthesis results, and input from National Science Teachers Association members in developing the desired state paper. The process took twelve months and involved six major redrafts following critiques from a panel of experts selected from elementary-secondary education, teacher education, science, private enterprise, and government.

It is not surprising that a single set of criteria developed by such means would be difficult to reach. A desired state is exactly that, a goal for which to strive. Programs that approximate the desired state provide a rich, meaningful learning environment for their students. Students can learn to recognize and solve problems in a meaningful context. They experience science in the real world.

Science is more than a body of information; it is a set of relationships with multiple interactions. Our effort to understand these relationships and interactions often results in revision of our interpretation of the universe and may lead us to further observations. Students having further experiences with such programs should, as adults, appreciate the role of science in society—a role in which science is viewed as a tool, not as a controlling force.

A Brief Summary of the Exemplars

The Onslow County energy education program is an interdisciplinary, community-based program with inter- and intra-grade level articulation. Each year nearly 15,000 students enrolled in public and private schools within Onslow County participate. Wise stewardship of our energy resources is the focal point. Students and adults are actively engaged in a wide variety of activities focused on stewardship. Curriculum materials developed within the county, at the North Carolina Department of Public Instruction, and at various businesses and industries are used to reach objectives established within the humanities, social sciences, and natural sciences.

The culminating event each year is a county-wide energy fair. Events leading up to the county fair include local school fairs, stage performances, public speaking contests, poetry contests, and bumper sticker contests. Each year the school that conserves the most energy is given a conservation award. The community is not overlooked in this broad-based program. One day each year is proclaimed Energy Sunday, complete with biblical references to energy conservation in church services. Homes belonging to senior

citizens are weatherized; energy audits are provided free of charge to area residents; and a regular newsletter is published to inform citizens about county energy education events and activities. This program, beginning as one person's vision in the summer of 1979, has grown to become a major activity of public and private schools within Onslow County.

As impressive in size and cooperative spirit is *The Best of Energy Books*/$1,000,000 Challenge of the Denver public elementary schools. This program involves elementary school students, teachers, administrators, and custodians in a program of energy education and conservation. Three major components exist in this program—*The Best of Energy Books*, workshops, and the $1,000,000 Energy Challenge. The energy challenge has resulted so far in a $180,000 reduction in school utility bills. The workshops have involved parents and all school personnel in energy conservation activities; in addition, teachers have been taught how to use *The Best of Energy Books*.

The Best of Energy Books are two volumes, grades 1–3 and grades 4–6. Each energy lesson is categorized according to a primary subject area—art, language arts, mathematics, science, and social studies. The basic idea of each lesson is denoted by a logo. The ideas are incorporated into all five subject areas. Each of the more than 100 lessons contains a major idea or concept, objectives, list of needed materials, student activities, teacher background section, and a supplemental materials list. These books make the teaching and learning of energy education concepts and ideas a pleasant task.

The Energy Management Center is the science and energy center for 31 Pasco County Florida schools. Each year 13,500 students in grades 4–12 visit the center to study energy ideas and concepts. Although energy education activities are available for students and teachers of all levels, grade four is the target grade. The six professional staff members of the center conduct a three-day energy education inservice workshop for all fourth grade teachers to help them implement three 3-week modules and a two-day field trip to the center. The three modules, Let's Learn About Energy, Nature's Energy, and Man and Energy, were developed, field tested, and disseminated as part of an Elementary Secondary Education Act, Title IV C project. Each module contains resource information, laboratory materials, and student activities.

A teachers' method book provides rationale and objectives, a materials list, vocabulary lists, supplementary student learning activities, and student evaluation materials for each module. Student activities are integrated with art, language arts, mathematics, science, and social studies. The value of energy and an appreciation of its effects on the environment are stressed through direct experience in the outdoor setting. Evaluation data support the concurrent attainment of both cognitive and affective goals by students in this unique program.

The Outdoor Education Center of the Houston Independent School District is another large center providing elementary school students with energy education in an outdoor setting. The program is designed to provide fifth grade students with a one week residential experience to learn about forms of energy, energy use and issues, energy futures, and citizen responsibility. While at the center, students read electrical meters, write to government agencies, devise personal energy conservation plans, cook with solar energy, watch films, and more. These activities are integrated into the school district's language arts, mathematics, science, and social studies curriculum. Each activity at the center is designed to enhance a specific cognitive or affective objective in the fifth grade curriculum.

At the Energy Studies Center in Portland, Oregon, energy concepts and ideas are integrated with the district's curriculum scope and sequence. Areas of the curriculum include home economics, industrial arts, language arts, mathematics, science, social studies, and reading. One striking feature of this program is the local community and school administration's commitment to an energy education program that is clearly part of the total curriculum. In each building a trained building energy coordinator was appointed to provide faculty with support and encouragement and to link the faculty with resources at the Energy Studies Center. These coordinators receive an additional 3 percent pay for their added responsibilities.

Rather than develop large amounts of curriculum, the staff carefully selected materials from existing sources. Teacher inservice education is an essential component of this model—over 65 percent of the district's K–12 teachers have received energy education training, lesson plans, and supplementary materials. Choices made at the building level have resulted in diversity with a common focus. One outcome of the program has been a reduction of electrical energy use in the Portland Public Schools of 4,185,000 kilowatt hours.

One unique program is Poss's Energy Posse from the Pond Hill School in Wallingford, Connecticut. This is a year-long interdisciplinary activity-centered program involving career, consumer, and energy education for students in grades K-5. OccuPossum, a puppet, works primarily with second grade students. OccuPossum leads the students on an energy "audit" of their school. While on the audit several energy wasters, for example 'Lectric Looie, Heat-Loss Harry, Drippy Dora, and Junk-Food Jane are found. The second graders are deputized, and the experience serves as the basis for energy discussions throughout the school.

Learning activities are selected to develop awareness of how energy is used in our lives, its impact on our future, and its role in our society and economy. A goal of every activity is to aid students in the development of decision-making skills. The program is a framework rather than a curriculum to be adopted and followed. Each teacher is encouraged to develop a personal teaching style and unit preferences. Energy materials available to teachers do not replace regular subjects; instead they are designed to enhance the development of concepts, skills, and attitudes within the existing curriculum. The culminating activity at the end of the school year is an energy rodeo where students display their energy projects.

One of the oldest energy education programs, Energy and Electricity, started in 1970 in Renton, Washington. This program provides a comprehensive five week unit of study for all fifth grade students in the Renton School District. Hands-on investigative activities are integrated into the science lessons to enhance learning about energy resources, use, and conservation. An 11 lesson kit of materials is supplied to each teacher. The kit contains an exten-

sive teacher's guide, lesson plans that include concepts, performance objectives, material requirements, teaching tips, student worksheets, and all the necessary manipulative materials that are needed for a class of students to conduct the investigations. When the unit is completed the kit is returned to the district office for storage and restocking. Lesson activities are designed to develop classification of observation, measurement, data collection, prediction and inference skills. The final activity is a full-day field trip to learn about the present and historical uses of fossil fuels in the area and the importance of hydroelectric resources to the region.

Another project is the Energy Education and Physical Sciences program of Jonas Clarke Junior High School in Lexington, Massachusetts. This program started in 1972 when the school opened and is a model for infusion of energy studies into a laboratory science course. The original curriculum was an eighth grade introductory physical science program. Appropriate energy activities have been infused throughout the laboratory and discussion phases of the program. Energy topics provide relevance for the study of physical science. Students experience science as a part of their environment. Critical thinking and decision-making skills are emphasized in all activities. Teachers model behaviors they expect their students to acquire.

Students produce eight reports on selected energy topics during the year. Information is gleaned from laboratory activities, printed materials, news media, community members, and parents. Each report ends with consideration of a social issue and discussion of trade-offs involved—truly a multidisciplinary activity! The study of energy and physical science climaxes each year with an "energy expo." This fair involves the display of student designed energy experiments and demonstrations to the entire student body, faculty, parents, and members of the community.

Further Thoughts

These eight programs are diverse in nature yet alike in quality. They have made much progress in the relatively new area of study called energy education. In all programs students learn science in a meaningful context and become scientifically literate adults. There is much work yet to be accomplished. Programs that deal with the science-society interface are not common or are extremely short units of study. Usually the units ignore senior high students who should all be dealing with significant science-society issues.

In chapter 1 the task force identified eight characteristics of exemplary energy education programs. Several characteristics deserve further consideration in light of our present knowledge about successful energy education programs. For a course to deal with the science-society interface, the content and instructional activities must use the humanities, natural sciences, and social sciences. At least five of our national exemplars did this—all at the elementary school level. We did not identify a secondary school program that integrated the humanities, natural sciences, and social sciences. Perhaps this is a reflection on the preparation of secondary school teachers, most of whom are specialists in a single discipline. It may also reflect on the practice in the secondary school of categorizing courses into traditional subjects for the purpose of determining credits. Those are long-standing characteristics of the secondary school; we do not, however, need to let that limit our progress. We can work together as teams of teachers representing a broad discipline base; we can award students credit for gaining useful experience rather than just for completing traditional courses.

Inter- and intra-grade level articulation and coordination must exist for the progressive development of energy concepts, practices, and attitudes. Many goals espoused by people developing energy education programs require students to develop problem solving skills. These same programs require students to practice energy conservation. Both of these behaviors are complex, requiring systematic development. When an energy education program exists physically apart from the rest of the school curriculum and is taught by a different staff, it is hard to bring about effective articulation and coordination. Coordination can occur with little effort. Articulation, however, implies that the pieces fit together in a precise working manner much like a knee joint or fine mechanical instrument. It is difficult to obtain this level in most energy education programs. We must continue to fully integrate energy education concepts into the total curriculum.

There is no school, no community, no state free from energy problems. Many of the issues are similar and require similar solutions. Each school, community, and state has unique issues that can serve as a reservoir of problems and issues for study and as a source of enlightenment. Our exemplary programs, and other energy education programs throughout the nation are doing a commendable job incorporating community resources. This is a unique contribution that energy education can make to the total school curriculum.

Program aims should be ambitious. Program and student evaluation techniques must reflect these aims. The instructional materials we examined lead us to believe that many programs are providing students with an opportunity to develop good thinking and learning skills. Perhaps in time all programs will provide students with similar opportunities.

We have much work ahead in the area of program and student evaluation. Few energy education programs demonstrate a comprehensive ongoing evaluation process. Such a process requires the cooperation of evaluation and measurement persons and the support of school administrators. Major coordinated efforts are needed in this area.

Chapter 1 stated that an ideal energy education program builds upon existing instruction, organizes seemingly unrelated academic disciplines, explores issues and decisions, uses a diversity of expertise, and fits into the present educational program. In less than a decade we have many programs that have made great progress toward reaching this ideal state.

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